THREE ESSAYS IN THE ECONOMICS OF EDUCATION

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Abstract:

Education has become increasingly important in today's society. In the three essays of this dissertation, I analyze the impacts of government education policies on elementary and high school students in Ontario.

The first two essays measure the costs and benefits of programs that allow students to choose from a wider range of high schools. Theoretically, increased choice could benefit students since schools might compete for students by improving their productivity. The third essay of this dissertation, coauthored with Jean Eid and Christine Neill, examines the impacts on students of a switch from half-day to full-day kindergarten.

In the first essay (Chapter 2), I document that students living in areas with more choice are more likely to apply to university. These outcomes seem to be due to competition between Public and Catholic school boards. I find that students attending public schools are more likely to apply to university when they are surrounded by more Catholic schools (and vice versa).

In Chapter 3, I examine a potentially negative outcome of increased choice. I find brighter students (as measured by their standardized test scores) are the most likely to use expanded choice to opt in to a different school. These bright students move to what are perceived to be the better schools, leaving behind weaker students at poorer schools. If peer effects are important, this has the potential to be harmful for weaker students.

In Chapter 4, my coauthors and I measure the impact of a switch from half-day to full-day kindergarten on standardized test scores administered in grades 3 and 6. We find that this universal program had no effect on the overall likelihood that a student passes these standardized tests. We do observe, however, small improvements in test scores for students living in low-income and low-education neighbourhoods.

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List of abbreviations and symbols:

DA – Dissemination Area (a neighbourhood defined by the census)

DSB – District School Board

EQAO – Education Quality and Accountability Office

FSA – Forward Sortation Area (the first three digits of the postal code; a larger area than the DA)

JK – Junior Kindergarten

HHI - Herfindalh Index (a measure of competition in a market)

SK – Senior Kindergarten

TDSB – Toronto District School Board

TCDSB – Toronto Catholic District School Board

Declaration of academic achievement:

I am the sole author of the first two of three thesis essays. The third essay, however, is co-authored with Christine Neill and Jean Eid, both of Wilfrid Laurier University. The three authors were equally responsible for the production of this work. Naturally, however, in collaborations of this nature, authors specialize and perform tasks to which they are most suited. Since I daily produce my research in the PEDAL lab, in which the data for this project is housed, I was primarily responsible for conducting the data preparation and STATA analysis. My coauthors took primary responsibility for the planning, background research and writing of results.

1) Introduction

It is well understood that education is associated with a vast range of positive outcomes for individuals and society. Governments and policy-makers have therefore long sought to increase the education levels of their populations through provision and/or subsidization.

Government education policies have recently placed an increased emphasis on accountability. In the U.S., the importance of accountability is stressed in the No Child Left Behind Act of 2001, which seeks to improve student outcomes through increased measurement, incentives to schools and teachers (including the threat of closure), and allowing students choice of which school to attend. In Canada, the emphasis on accountability has resulted in standardized testing in several provinces, and the public reporting of school results, with the intent that parents and students can choose a school they find desirable. Also, some school boards have explicit open enrolment policies designed to allow students more options than their local assigned school.

The three essays in this thesis attempt to measure the impacts of government education policies on elementary and high school students in Ontario. Each of the essays relies on data from Ontario's Education Quality and Accountability (EQAO) standardized test scores, among other data sources. The first two essays focus on the impact of increased choice on outcomes of high school students, while the third examines the impact of a switch from half-day to full-day kindergarten.

There is a fairly large existing literature on school choice, although it is mostly in a U.S. context. The Canadian literature is considerably smaller. The first essay provides a comprehensive literature review on the overall issue of school choice. The literature review of the second essay focusses on the impacts of school choice on the sorting of students across schools.

Theoretically, there are at least two ways in which increased choice could benefit students. First, if parents and students move to schools they believe to be superior, schools may have to compete to attract students. This competition for students might act to increase the productivity of schools, and thus improve student outcomes. A second way in which increased choice might lead to better outcomes is simply as a result of allowing better matches between students and schools. If, for example, an artistic student would do better in a school specializing in the arts, he/she is more likely to find such a school if he/she can choose from multiple schools as opposed to being restricted to attending only the local neighbourhood school.

In the first two essays, I attempt to measure the impacts on students of increases in the ability to choose between schools. That is, I measure the number of high schools that are accessible to a student from their location of residence. Due to differing policies across Ontario school boards, and because of differences in population density, the number of schools accessible to students living in different areas may be substantially different. For example, in areas of downtown Toronto, it is not uncommon to find that students from the same residential block attend twenty or more different high schools. On the other hand, in rural areas, students may have only one or two schools that are reasonably accessible.

In the first essay, I examine the extent to which increases in choice are associated with increases in a long-term student outcome: whether the student applies to university. This paper contributes to the literature in several ways. First, I use data from the unique context of Ontario, where two publicly-funded school boards operate in parallel and compete for students and government funding. Second, I use a methodology that takes advantage of discontinuities in the likelihood of being able to attend a given high school arising from school board boundaries. By comparing otherwise similar and nearby neighbourhoods on opposite sides of a school board boundary, I am able to identify the effect of a change in the extent of school choice.

I find a positive effect of increases in the number of accessible schools on the likelihood of university application. However, I find that most of the effect is in terms of "cross-board" effects; that is, if a student attends a *public* high school, they are positively impacted by an increase in accessible *Catholic* high schools (and vice versa). I argue that this is suggestive that the primary mechanism through which choice impacts students is through competition between the public and Catholic school boards.

The second essay examines a potentially negative outcome of increased school choice. One concern about increased school choice is that it may be that the brightest and most motivated students are the ones to benefits most from it. If it is the brightest students who leave poorly performing schools to go to stronger schools, this leaves behind weaker students at the weaker schools. If peer effects matter, this could be detrimental to these weaker students who now are surrounded by a weaker peer group.

In this essay, I use a new dataset, which allows me to link grade 6 EQAO test scores to grade 9 EQAO test scores. This means that I observe the student in elementary school (and thus know the elementary school he/she attended) and observe the student again in high school (and know the high school the student attended). Based on the elementary school attended and school board rules about which elementary schools feed which high schools, I also know the high school the student would have been assigned based on his/her residence. I am therefore able to create a variable indicating whether a student "opted out" of his/her assigned local high school.

I find that it is indeed the brightest students (as measured by their grade 6 test scores) who are most likely to opt out of their assigned high schools. Not surprisingly, the more choice the student has in terms of accessible schools, the more likely he/she is to opt out. The interaction between these two effects is also positive; greater choice has a greater impact on brighter students. Finally, I provide some descriptive analysis showing that the students who opt out are more likely to attend another high school with a stronger peer group. Taken together, this implies that increased school choice does in fact lead to less heterogeneity of students within a given school and more disparity of average test scores across schools.

The third essay of this thesis moves away from the study of choice. In this study, with coauthors Christine Neill and Jean Eid, I examine the impacts of a government policy to switch from half-day to full-day kindergarten. Students in the latter system receive double the amount of schooling during their kindergarten years (junior and senior kindergarten). We examine whether the impacts of this increased schooling can be observed in terms of student EQAO test scores in grades 3 and 6, which is a relatively long-term outcome for this literature.

Our methodology hinges on the fact that the change to full-day kindergarten was introduced in the French board of Ontario well before the English boards. We therefore use a difference-in-difference methodology where English students in the same region act as a control group for the French students who received the "treatment."

We do not find any overall effect of the policy change on test scores. This is not uncommon in the literature, however, for two reasons. First, it is not uncommon in the early-learning literature to see results at six months after the program that fade quickly with time. Secondly, most of the studies that find large results of early-childhood interventions study programs that are quite targeted in nature (for example, targeted at poor children), whereas universal programs are less likely to have large overall effects. We do, however, observe some heterogeneous treatment effects. For example, we do see positive effects of full-day kindergarten on students in the lower half of the test score distribution living in neighbourhoods with low-income and low-education levels.

2) Choice of Ontario High Schools and its Impact on University Applications

2.1 Introduction

The potential for improved student outcomes due to increased choice of which school to attend has generated a large literature in the United States. There are at least two potential mechanisms through which increases in school choice could influence student outcomes. The first mechanism is a direct effect on students who switch schools and may thereby benefit from a better fit at the new school or a better peer group. The second mechanism is through a general increase in school productivity due to increased competition for students.

Usually, studies of this issue seek to answer one of two questions. The first concerns whether students living in areas with more choice of schools[1] have better outcomes than otherwise similar students living in areas with less choice. The second question concerns whether policies designed to increase school choice (for example, vouchers for private schools or "lighthouse" schools) can increase student outcomes. Typically, past studies have found a small positive impact of increased choice/competition on student outcomes.

[1] This is sometimes referred to as "Tiebout Choice" since families can choose to "vote with their feet" and move to areas with greater choice of schools or better schools.

The context in the province of Ontario, Canada is unique for studying the impacts of school choice. In all Ontario jurisdictions, two publicly-funded school boards coexist: namely Public (secular) Boards and Catholic Separate Boards. As a condition of their public funding, Catholic high schools are required to accept non-Catholic students. Therefore, under the Ontario system, every high school student has the choice of *at least two publicly funded high schools*. In practice, however, I show that the students in my sample of the Greater Toronto Area have access to considerably more than two publicly funded schools.

With this study, I contribute to the existing school-choice literature in several ways. Most importantly, I use a longer term student outcome: the percentage of high school students applying to university. I make use of data from the Ontario University Application Centre (OUAC), which collects information on all applicants who are residents of Ontario and apply to Ontario Universities. Since I cannot directly link the OUAC data to student level data for test scores and high school attendance, I aggregate the data to the smallest level of census-defined neighbourhood (Statistics Canada refers to these neighbourhoods as "dissemination areas," or DAs). Therefore, my dependent variable is the university application rate (i.e the number of high school applicants to university from the neighbourhood divided by the total number of high school students in the neighbourhood).

Using attendance data for Ontario high schools, I establish a school travel zone for each school based on the actual attendance patterns of its students. As my measure of choice or competition, I use the count of these travel zones in which a given neighbourhood falls. In other words, I count the number of high school to which a student living in that neighbourhood has access, based on each school's observed travel zone. I then regress the university application rate for the neighbourhood on the number of accessible schools.

In order to deal with potential omitted variables and endogeneity issues, I exploit the fact that while students often attend high schools other than the closest to their residence (and other than that assigned to their area of residence), they rarely cross school board boundaries. My empirical strategy is to exploit these "boundary discontinuities" by examining matched pairs of otherwise similar neighbourhoods (DAs) on either side of a school board boundary.

The next section provides a detailed review of the literature. Section 3 discusses the institutional context in Ontario and the data setup. In section 4, I describe my empirical strategy. Results are discussed in section 5 and section 6 concludes.

2.2 Review of the Literature

The Theory – Why might increased school choice lead to better student outcomes?

Direct Effects on Students

There are at least two potential mechanisms through which increases in school choice could influence student outcomes. The first is a direct effect on students who change schools. Typically, it is assumed that allowing student (or their parents) choice in which school to attend would allow students attending low-performing schools to switch to higher performing schools. The students would therefore benefit from a positive peer effect due to surrounding themselves with brighter or more motivated colleagues and/or better teachers. In the US, this has typically meant moving students from poorly-performing inner-city schools to better-performing schools in suburbs (or to private schools via vouchers). Studies which examine the impacts of changing schools on individual outcomes include Cullin, Jacob and Levitt (2005, 2006) and Booker (2008).

As described by Belfield and Levin (2002), there are a number of US programs aimed at increasing school choice. These include vouchers for private schools (i.e. students are provided a subsidy for all or part of the tuition associated with attending a private school) and "charter schools" (privately managed schools which receive public funds provided they demonstrate success). Hoxby (2000), however, argues that the most prevalent form of choice in the U.S. is that of "Tiebout Choice." That is, students/parents choose to move to a different location (i.e. giving the right to attend a different set of schools) within a given cosmopolitan area which better meets their educational needs.

As noted by Hoxby (2000), the possibly negative aspect of increased school choice is increased sorting of students by ability. That is, students who are left behind (i.e. those at low-performing schools who do not switch schools) may face the opposite effect. If the good schools "cream-skim" off the best students, students who are left at the poor schools will face negative peer effects as the average student outcomes decrease at those schools.

Competition between schools

The second mechanism by which increased school choice can increase student outcomes is through a general increase in school productivity brought about by an increase in competition to attract students. This competition could take place at various levels. Underlying this "competition" mechanism for increasing school quality is the assumption that school managers (potentially school principals or school board trustees) are motivated to increase the size of their schools. In the case of private schools or post-secondary institutions, they likely seek to increase the enrolment at their schools because they are profit maximizers.

For publicly-operated schools, managers might seek to increase enrolment because school funding is based on the number of students attending the school. Also, school supervisor pay might be based on the size of the school or school board. For the case of Ontario public schools, the theoretical model of Card, Dooley and Payne (2010) explicitly assumes that school managers have the *share* of local students attending their school as an argument in their utility functions.

It is not necessarily the case, however, that the possible loss of students to other schools is the main motivation for school managers to work toward improving student achievement. Jacob (2005), for example, finds fairly large increases in test scores at Chicago Public Schools due simply to an "increased accountability measure" that tied measured school performance to existing standardized tests. In this case, there was no increased competition; simply defining the standardized test as a measure of the school's success resulted in an increase in test scores.

The idea that schools compete for students based on their quality relies on a second assumption. One must also believe that students (or their parents) can measure school quality and react to it. Rothstein (2004) notes that, while there is ample information on educational outputs (i.e. standardized test scores), there is much less information on inputs (e.g. quality of incoming students). Parents may therefore have difficulty in evaluating which are the effective schools. Rather, they are likely to simply assume that the schools with the highest outputs are the most efficient. Presumably, however, what parents/students are really interested in is some measure of value-added in terms of the quality of the incoming students to the school and their results upon having attended the school.

Competition between schools could take place at various levels. For example, Hoxby (2000) examines competition for students between school boards within a metropolitan area. Hoxby postulates that in areas where there is more Tiebout competition (i.e. where parents/students can vote with their feet and move to different school boards within the same metropolitan area), there will be greater school quality.

Card, Dooley, and Payne (2010) measure the impacts of competition between public and Catholic elementary school boards in Ontario. They use the percentage of Catholics in the area (and the growth rate of the area) as a proxy for the extent of competition that the public school board faces from the separate board. In principle, the competition could take place between public schools within a school board, between private and public schools, or wherever else students or their parents might consider as alternatives to their assigned public school.

Empirical Issues

Measures of School Value-Added

In order to measure the impact of competition on school value-added, one must have measures of both competition and school inputs and outputs. There are multiple ways of measuring each. As discussed in Belfield and Levin (2002), school outputs are relatively easy to measure and may include: standardized test scores, graduation rates, subsequent employment and wages, and crime rates. Most studies reviewed by Belfield and Levin (2002) used either academic outcomes (e.g. standardized test scores) or attainment rates (e.g. graduation rates) as their measures of outcomes.

Even these outputs, however, have their challenges. One of the most well-known American standardized tests, the SAT, suffers from the fact that students self-select into writing the test. Therefore similar average scores across schools may mask large differences in the likelihood of writing the test (and, presumably, those who do not write are those who did not expect to do well on the test). And Jacob (2005) notes that, when standardized testing becomes the measure by which teachers or school managers are judged, they may "teach to the test" or reduce efforts in other areas such as the arts in order to produce better scores. If this is prevalent, even standardized test scores may not be a good measure of school outputs.

School inputs are even more difficult to measure, but would ideally include the quality of incoming students, the amount of money spent, and teacher quality among other things. Presumably, a policy maker would want to measure school effectiveness as outputs per a given amount of input. Parents, however, might only be interested in sending their child to the school that will make the biggest positive difference to their child's outcomes. They, therefore, might not care about the absolute level of funding the school receives (something that will obviously be important to the policy maker). Furthermore, for parents/students deciding on which school to attend, Rothstein (2004) notes that they may be unable to identify the most effective schools, although they may well be able to identify those with the highest measured outputs. This is because, while standardized test scores are widely available, information on the ability of incoming students and funding levels may not be. Some studies, such as Card, Dooley and Payne (2010), control for grade 3 test scores (i.e. the average for the school) in order to provide a measure of school value-added by grade 6.

Measuring Competition

The most common way in which competition is measured is the Herfindalh Index (HHI), which essentially assumes that the more schools (or school boards) a student could potentially attend, the more competition. The HHI is the sum of squared individual school (or school board) enrolments divided by the squared total enrolment.[2] It is therefore bounded by 0 and 1, where 0 indicates perfect competition with an infinite number of small schools and 1 indicates monopoly. For ease of interpretation, some authors use 1 minus the HHI, such that unity is the measure of perfect competition.

There are several caveats surrounding the use of the HHI. The first, as noted by Belfield and Levin (2002) is that, depending on the region of study, the HHI can often be little more than a measure of urban versus rural. That is, urban areas tend to be measured as competitive due to the larger number of schools whereas rural areas tend to be measured as non-competitive.

The second caveat is that any measure of competition may be only weakly correlated with the perceived competition to which school managers react. For

[2] So, for example, if there were 3 students in total in the area of interest and they went to three distinct schools (or school boards), the Herfindahl index would be 1+1+1/ 9 = 1/9, whereas if they all went to the same school (or school board), the HHI would be 9 / 9 = 1.

example, in a study of English schools, Levacic (2004) finds only a very small correlation between the extent to which headteachers (principals) believed themselves to be in competition with other schools and structural measures of competition.

There are many other potential ways to measure competition between schools. In addition to the HHI, for example, Hoxby (2000) uses simple counts of the number of school districts within a metropolitan area. Belfield and Levin (2002) note that another common measure of competition is the percentage of private enrolment (i.e. measuring the competition between public and private schools). Similarly, since only Catholic students can attend Ontario's Catholic elementary schools, Card, Dooley and Payne (2010) use the percentage of Catholic families within a district (as well as the same measure multiplied by the area's growth rate) to measure the level of competition between public and Catholic elementary school boards.

Sources of Exogenous Variation in Competition and/or Instrumental Variables

The extent of choice amongst schools in a given area is not randomly assigned. In particular, and as noted above, competition measures tend to be greater in urban areas than rural areas and are strongly correlated with measures of population density. While one can control for population density in regression analysis, authors of most studies are also concerned that the competition measures are somehow endogenous to other (possibly unmeasured) neighbourhood characteristics. They therefore seek to find plausibly exogenous sources of variation in the choice/competition measures using various methods. The two most common methods are exploiting changes in policies and using instrumental variables.

A typical way of finding exogenous variation is to examine a policy change which causes a variation in the level of choice or competition. In the US context, there are many examples of the introduction of policies such as vouchers or "lighthouse" schools, which are intended to increase the choices available to students. By comparing student outcomes before and after the policy, researchers can estimate the program effects. An example of such a methodology is provided by Chakrabarti (2008), who studies the effects of a court-ordered increase in the number of schools eligible to receive vouchers. Cullen, Jacob and Levitt (2006) exploit randomized lotteries that determine admissions to Chicago public high schools; thus otherwise similar students face exogenously different levels of available choice.

In her paper on Tiebout competition, Hoxby (2000) proposes what is surely the most creative identification strategy. Hoxby studies the number of school boards surrounding a metropolitan area and its impact on test scores. Since Hoxby argues that the number of school boards (and thus the measure of competition) could be formed endogenously, she uses the number of naturally occurring stream and rivers in the metropolitan area as an instrument for the number of school boards. The basic intuition is that these bodies of water played a role in determining original school board boundaries, since school trustees are reluctant to force students to cross the bodies of water.

Gibbons et al. (2008) use a similar instrument to that which will be used in this paper. Since students are, for the most part, unable to cross Local Education Authority (an LEA is similar in concept to a school board) boundaries, Gibbon's et al. argue that students living near such boundaries have less school choice than students living in the middle of an LEA. They therefore use the proximity to an LEA boundary as an instrument for the level of choice faced by the student.

The Findings

Belfield and Levin (2002) review 35 studies on competition and educational outcomes in the United States that were published between 1972 and 2001. Overall, Belfield and Levin conclude that there is "reasonably consistent evidence of a link between competition (choice) and education policy." However, they note that the effects are "modest in scope with respect to realistic changes in levels of competition."

With respect to academic outcomes (i.e. test scores), Belfield and Levin report that out of 206 regressions in the reviewed studies, 38% reported positive and statistically significant coefficients on levels of competition. The typical size of the effect, however, was small. An increase of one standard deviation in the measure of competition (typically the HHI) was associated with an increase in outcomes of less than 0.1 of a standard deviation.

With respect to school attainment (usually graduation rates), out of 52 regressions, Belfield and Levin report that 42% were statistically significant. In this case, an increase of one standard deviation in competition was typically associated with an increase in school attainment of between 0.08 and 0.18 standard deviations.

Impacts of Competition on School Quality

It is worth emphasizing Hoxby's (2000) results given that they are the subject of several subsequent papers. Based on the methodology described above (streams and rivers as instruments for the number of school boards), Hoxby finds a statistically significant impact of Tiebout competition on school productivity, with a one standard deviation increase in measured competition associated with a 0.27 standard deviation increase in test scores. These results would be fairly substantial if one were to compare the top end of the Tiebout choice spectrum to the bottom, but are more modest when one considers realistic changes in choice.

In his own study, however, Rothstein (2004) finds no evidence that school quality rises with choice. Rothstein argues that if parents and students are more concerned about peer groups than school effectiveness (or if they cannot measure school effectiveness), they will sort themselves toward schools in better neighbourhoods, but not necessarily the most effective schools. He finds that students move to schools with better peer effects rather than those of high quality.

More recently, Card, Dooley and Payne (2010) use data from Ontario to examine the effects of competition between Catholic and Public school boards. They find a small but statistically significant positive effect.

A final study, Chakrabarti (2008) examines differences in voucher programs and their differing effects on public school boards' incentives. Chakrabarti finds that increasing the number of schools eligible to receive voucher students (as a result of a court decision making religious schools eligible) increased school quality. He concludes that the design of voucher programs makes a difference.

Direct Impacts on Students who Switch Schools

Several studies focus on the direct impacts on students who change schools. Cullin, Jacob and Levin (2005) examine the Chicago Public School system, where roughly half of all students opt out of their assigned schools. They show that students who switch schools are more likely to graduate, but argue that this is mostly due to unobserved heterogeneity. This is because it is the most motivated (or those with the best parental influences) who are the most likely to switch schools.

Cullin, Jacob & Levin (2006) again focus on Chicago schools, but this time take advantage of the fact that students applying to schools with a limited number of spaces are selected by a random lottery. By comparing those students who win and lose these lotteries, Cullin, Jacob and Levin show that there is little evidence that winning a lottery to go to a higher performing school increases the test scores, graduation rates, or number of earned credits of affected students. However, they do show some evidence of improvements in non-traditional measures such as discipline problems and arrests, but winning students are no more likely to enjoy school or trust teachers. Further, Cullin, Jacob and Levin note that students with most to gain benefit the least. That is, students with the lowest grades see little or no improvement after switching schools. It may be that these students are better off staying in their local schools, surrounded by peers with whom they are more similar.

On a more positive note, Booker et al. (2008) find fairly large impacts of attending charter schools on attending college. Like Cullin, Jacob and Levin (2006), however, Booker et al. find that students with low test scores are the least likely to benefit.

2.3 Institutional Context and Data

Before discussing the empirical strategy and data, I review Ontario's high school system and university application process in more detail.

Currently, high school education in Ontario consists of grades 9 through 12. Prior to 2003, a fifth year of high school study was required in order to attend university, which was referred to as the Ontario Academic Credit (OAC) year. The phase out of the fifth year of high school resulted in what is referred to as the "Double Cohort," where the final cohort of students required to complete five years of high school graduated at the same time as the first cohort of students requiring only four years to graduate. In practice, due to the intense competition for university admission, some students tried to avoid graduating during the double cohort year. Of those students requiring the OAC year, some tried to "fast-track" and graduate in only four years (thus graduating in 2002). Of the cohort of students requiring 4 years of high school, some deliberately took an additional year of high school (thus graduating in 2004). Therefore, the number of students applying to university in each of 2002, 2003, and 2004 was somewhat higher than is typical.

A distinguishing feature of the high school education system in Ontario is that, in all areas of the province, two *publicly funded* school boards coexist: namely Public (secular) Boards and Catholic Separate Boards. For example, within the area of downtown Toronto, there exist both the *Toronto District School Board* and the *Toronto Catholic District School Board*. The Catholic School Boards may or may not share the same boundaries as the Public School Boards (in the case of the Toronto District Boards, they do). Both boards receive the same amount of public funding per student. Teachers in both boards are covered by collective agreements and are paid roughly the same.

At the high school level, students of all denominations have the right to attend Catholic Separate Schools.[3] Therefore, all students at the high school level can choose between at least two high schools: the Catholic and Public high schools assigned to the area in which they live. There are also private schools (both faith-based and non-

[3] However, students of all faiths attending Catholic school may be required to take courses in Catholicism. Whether a non-Catholic can avoid taking these courses (and the degree of difficulty in doing so) varies by board and sometimes by school.

denominational) which provide even more choice, but I ignore these in this analysis and focus only on publicly-funded schools.

In practice, I show that students have considerable choice in high schools. Indeed, it is not uncommon in downtown Toronto for students from the same city block to be attending 15 or more different publicly funded high schools. This shows that it is relatively easy to attend a high school other than the one that is assigned given the student's area of residence.[4] Critically for my methodology, however, it is rare for students to cross school board boundaries. Over 99% of all students attend high school in the school board in which their residence is located.

Applications to University

During grade 12 (or, until 2003, grade 13/OAC) students decide whether to apply for university for the following year. They do so by applying to the Ontario University Application Centre, which allows them to apply to three Ontario Universities for a fixed fee. A key institutional feature of the Ontario school system is that it is relatively closed. That is, 95% of undergraduates from Ontario attend an Ontario university (Dooley, Roob & Payne, 2010). It is likely, however, that even those students who end up going to out-of-province universities would apply to Ontario universities as well.

[4] The ease with which a student can attend a school other than his/her assigned high school also varies by school board. In Toronto District School Board (TDSB), for example, there is an explicit policy of "Open Enrolment," which allows students to apply to any high school within the Board. If the high school is below its capacity, the student will be accepted. The TDSB has a series of rules (referred to as a lottery, although there is no element of chance) to prioritize students when the high school is at its capacity. Students from the area assigned to the high school get priority over students from elsewhere.

Therefore, the OUAC data have a nearly complete list of all Ontario applicants to universities.

Data

The data come from four main sources, which overlap from for the years 2000-2004.

University Applications – OUAC

The primary data source for this study is from the Ontario University Application Centre (OUAC). The OUAC dataset contains information on Ontario applications to Ontario universities. Each high school student is entitled to apply to three Ontario universities. The OUAC dataset tracks: the universities to which students apply, the programs to which they apply, their high school grades, and other demographic information including their postal code (which can be linked to census data on the DA and school level attendance data).

High school attendance, by postal code

I also make use of data for attendance at Ontario high schools by postal code. For each high school in Ontario, my dataset provides the number of students attending from each postal code (i.e. the postal code of the student's residence).

High-school test scores – EQAO

In Ontario, the Education Quality and Accountability Office (EQAO) conducts standardized tests of grade 3, 6 and 9 students. I make use of grade 9 math test scores as a key control variable.

Census data by DA (Census year, 2001)

I also make use of 2001 census data which include important control variables such as income, education, housing values, percentage immigrants, ethnic origin, and population density.

Data Aggregation at DA Level

Given that I want to examine the probability of applying to university, it is necessary to have data on the students who do not apply. Unfortunately, I am limited by the fact that I cannot directly link my data sources. That is, while I have information on each student who applies to university, I cannot directly link those data to the information on high school attendance and test scores.

I deal with this problem by aggregating all of my data to the level of Statistics Canada's Dissemination Area (DA). This is the smallest level of aggregation for which census data are available. These dissemination areas are neighbourhoods that, on average, have about 45 high-school students.

Aggregating the OUAC data to the DA level provides counts of university applicants from each Ontario DA (I count each student who applies to at least one

Ontario University). Linking these data to high school attendance data, we therefore observe the percentage of high school students applying to university from each DA (the numerator being the OUAC count of applicants from the DA and the denominator being all high school students in the DA).

One minor problem is that I do not have information *by grade* by postal code (we have only the total number of high school students). Therefore, the denominator is all high school students rather than all grade 12/OAC high school students. As a rough ballpark figure, if students are evenly distributed from grades 9 through 12, the highest university application rate we would expect to see would be 25% (i.e. all grade 12 students apply but no students from grade 9-11 apply).[5] One advantage of using the total number of high school students as the denominator, however, is that it is easy to deal with Ontario's double cohort since it avoids the difficult issue of deciding which grade 12 and OAC students should be included in the denominator. The attendance rates around the year of the double cohort are simply higher than in other years, but this is controlled for using year dummy variables.

Using the procedure described below, I create counts of accessible public and Catholic high schools from each DA as my measure of competition/choice. I also control for the average test score from schools accessible from the DA.

[5] In fact, in my sample years, the Ontario-wide percentage of grade 12/OAC students varies from 29% in 2004 (grade 12 students only) to 34% in 2001 (grade 12 and OAC students).

The sample

I restrict attention to DA's in boards in and surrounding the city of Toronto. More specifically, I keep all schools and students records with postal codes starting with "M" or "L". I further drop the few remaining rural postal codes (i.e. postal codes where the second digit is 0.) This provides a sample that is entirely urban. Furthermore, the school board boundaries over which I will match neighbourhoods are urban on both sides.

Table 2-1 – Sample Sizes describes how I arrive at my working dataset. Restricting the data to DA's from the Toronto Area (postal codes starting with "L" or "M") provides 45,659 DA year observations (roughly 9,000 DA's per year). After merging with the census data and eliminating observations with missing data, I am left with 34,681 DA year observations. When I restrict the data to matched pairs of DAs (matching on income, education levels and housing values - see the Empirical Strategy, below), the resulting sample contains 5,311 matched pairs (just over 1,000 pairs per year). When I add grade 9 test scores to the match, the additional restriction decreases the number of matched pairs to 3,473 (around 700 per year).

2.4 Empirical Strategy

Creation of School Travel Zones

A first step in estimating the impacts of school choice/competition on student outcomes is creating a measure of school choice. I opt for a straightforward count variable: the number of public and Catholic high schools that are accessible from the neighbourhood (DA). In order to determine which schools are accessible from a given nighbourhood, I create school travel zones based on a methodology proposed in a working paper by Gibbons, Machin and Silva (2009), a paper that studied the impact of school quality on housing prices.

Gibbons et. al. use a revealed preferences method to create the school travel zones by using actual travel patterns of students to each school to generate the approximate shape of the catchment area. This method is more flexible than, for example, creating circles of a specified distance around each school, and gives a travel zone that better reflects where the students of the school actually reside. Furthermore, using the official travel zones of the high schools would neglect the fact that students may or may not come from those areas, and has the further drawback that almost all areas would have the measured amount of "choice" of only one or two schools (when, in fact, we know that students from the same neighbourhoods may go to many different schools).

Following Gibbons et al's method, and using the student's postal code, I create ten sectors radiating from each school location. Each of the 10 sectors captures 10 percent of the school's intake. In Gibbons et al's procedure, the first sector starts due west of the school and continues counter clockwise (I start due north and continue clockwise). The outer limit of each sector is delineated by the 75th percentile of the distance from the school of all students in that sector. Using the 75th percentile is intended to remove outliers who, if included, would make the generated catchment area too large to be representative of the areas in which a student could truly choose to attend that school. I recreate the school's travel zone each year based on attendance for that year. A typical school travel zone is depicted in Figure 1.

Once the travel zone of each school is established, it is straightforward to check whether each DA falls within this travel zone.[6] I simply count the number of school travel zones (of both Catholic and Public high schools separately) as my measure of school choice.[7] Since the school travel zones vary each year based on attendance, the same DA can have a different count of schools in different years.

Basic Regressions

As discussed, I would like to determine the effect of increased choice of high-school, as measured by a DA's count of accessible school travel zones, on the DA's university application rate. I, therefore, first estimate the following equations:

Total school counts:

$$UAR_{dy} = \beta_1 C_{dy} + \beta_2 G9_{dy} + \beta_3 D_{dy} + \beta_4 (B) + e_{sy} \quad (1)$$

Separated Public and Catholic school counts:

$$UAR_{dy} = \beta_1 C_{dyp} + \beta_2 C_{dyc} + \beta_3 G9_{dy} + \beta_4 D_{dy} + \beta_5 (B) + e_{sy} \quad (1a)$$

[6] To be more precise, I check whether the centroids of any of the postal codes within the DA fall within the school travel zone.

[7] I exclude French high schools and high schools with less than 25 students, as these likely are not in the choice set of most high school students.

where:

UAR_{dy} – university application rate in DA, d, in year, y. The application rates are similarly defined as one of the "total application rate" (total number of university applications from the public and Catholic high schools / total number of high school students at public and Catholic high schools), the "public application rate" (number of applications from students at public high schools / number of students attending public high schools) or the "Catholic application rate" (number of applications from students at Catholic high schools / number of students attending Catholic high schools)

C_{dy} – measure of choice (i.e number of school catchment areas in which the DA falls) of schools for students in DA, d, in year, y. These count measures are specified in two different ways: either the total number of high schools, C_{dy}, or Public and Catholic schools counted separately, C_{dyp} and C_{dyc}.

$G9_{dy}$ – average (unweighted) grade nine test scores at schools accessible in DA, d, in year, y. Since students have only attended one year of highschool for their grade 9 tests, I argue that these test results act as a measure of ability prior to highschool.

D_{dy} – a vector of demographic controls (census) for the DA d in year y. These controls include:

- Average household income
- Average dwelling value
- Average test scores from accessible schools

- Population density (of the fsa of the DA)
- Percentage of DA with a Bachelor's degree
- Percentage immigrant and new immigrant in the DA
- Percentage of DA speaking English
- Percentage of DA of Southwest and East Asian origin
- Year dummies.

B – a vector of dummy variables for the school board or the school board boundary (over which I match the neighbourhoods). In some specifications, I use boards/boundary fixed effects.

I also run specifications in which I use the disaggregated public application rates (i.e. number of university applicants from public schools / all public school students) and Catholic application rates as the dependent variable. In these specifications, the two rates (public and Catholic) are pooled, so that each DA represents two observations. The key school count variables are then multiplied by a dummy variable indicating whether the dependent variable is the Catholic or public application rate.

Total School Counts:

$$UAR_{dyp} = \beta_1 C_{dy} * P + \beta_2 C_{dy} * (1\text{-}P) + \beta_2 G9_{dy} + \beta_3 D_{dy} + \beta_4 (B) + e_{sy} \qquad (2)$$

Separated Public and Catholic school counts:

$$UAR_{dyp} = \beta_1 C_{dyp} * P + \beta_2 C_{dyp} * (1\text{-}P) + \beta_3 C_{dyc} * P + \beta_4 C_{dyc} * (1\text{-}P) + \beta_5 G9_{dy} + \beta_6 D_{dy} + \beta_7 (B) + e_{sy} \qquad (2b)$$

where P is a 0-1 variable indicating whether the observation used the public application rate. Therefore, 1-P indicates that it was the Catholic application rate.

Use of "Boundary Discontinuities" – Matching DAs Across Board Boundaries

It is likely that results from the simple regressions described above suffer from issues of endogeneity and potentially omitted variables. In particular, one might be concerned that the school travel zone count variables are somehow endogenous to the characteristics of the neighbourhoods surrounding the schools. People choose where they want to live, and one aspect of this decision is which areas have the best schools (or, possibly, the most choice of schools). Therefore, they might move to areas where there school options are better.

In order to find potentially exogenous variation in the school counts variables, I modify Gibbons et al.'s procedure by matching DAs across school board boundaries (Gibbons et al. matched housing sales across school boards). The logic is that while students have a considerable amount of choice in which high school to attend, they only very rarely are able to cross school board boundaries. That is, even though students do not necessarily attend the closest school, the likelihood of attending a given school decreases with the distance from the student's home. This probability takes a discrete and large drop as one crosses a school board boundary. However, the neighbourhoods on either side of the boundary may be otherwise very similar.

I exploit this discontinuity by matching similar DAs on either side of a school board boundary. Since the DAs are, by design, very close (geographically) to their match, one would expect them to have roughly the same counts of accessible schools. However, since the school travel zones do not cross school boards boundaries (because students do not), matched DA's have differing numbers of school travel zones; the differences are caused primarily by being on opposite sides of the school board boundary.

Using the original dataset, I match each DA observation with the closest similar DA across a school board boundary (with a maximum distance of 5 km between the centroids of the two DAs). Therefore, by construction, all DA's in this sample must be within 5 km of a board boundary (and the average distance from a boundary, by construction, must be less than 2.5 km). By similar, I mean that the DAs are close in a number of census characteristics. In order for two DAs to provide a match:

- Average DA income levels – must be within $20,000 of the matched DA (less than half of a standard deviation – see Table 2-2 – Summary of Main Variables).
- education levels – The percentage having a bachelor's degree must be within 5 percentage points of the matched DA (less than 1/3 of a standard deviation)
- Average DA housing values – must be within $50,000 of the matched DA (just over 1/3 of a standard deviation).

Even after the matching procedure described above, it could still be argued that there is potential endogeneity of the school count variables across school board boundaries. It is possible even within the similar neighbourhoods surrounding a board boundary that people choose to live on one side or the other of a school board boundary in order to access the schools in their desired school board. If this is the case, it is likely that the best students (or the parents who care the most) are the ones who are likely to move for the purposes of finding more choice of schools. This could cause an upwards bias to the coefficients on the counts variables in my regressions.

In order to try to address this potential bias, I add an additional criterion to the matching procedure. In this more restrictive matched sample, I add an additional requirement:

- Average Grade 9 test scores of accessible schools – must be within 0.1 (scores out of 4) of the matched DA (about ½ of a standard deviation).

This allows us to say that the students in a pair of matched DAs were roughly equal in average ability when they entered high school, and should help address the potential concern of the best students moving to areas with the most choice.

When matching the DAs across school boundaries, I restrict attention to the following six boundaries:

- Toronto DSB and Durham DSB;
- Toronto DSB and York DSB;
- Toronto DSB and Peel DSB;
- Peel DSB and Halton DSB;
- Halton DSB and Hamilton DSB;

- Hamilton DSB and Niagara DSB.

All six of these boundaries are also the boundaries between the corresponding Catholic School Boards. That is, for example, the boundary between the Toronto District School Board and the Durham District School Board is also the boundary between the Toronto District Catholic School Board and the Durham Catholic District School Board.[8]

Differencing model

Using the boundary discontinuity methodology, the regression analysis then compares differences between matched DA's on opposite sides of a school board boundary. The estimated equation therefore becomes:

Total School Counts:

$$(UAR_{dy} - UAR_{ey}) = \beta_1 (C_{dy} - C_{ey}) + \beta_2 (G9_{dy} - G9_{ey}) + \beta_3 (D_{dy} - D_{dy}) + \beta_4 (B) + e_{dy}$$

or

$$\Delta UAR_y = \beta_1 \Delta C_y + \beta_2 \Delta G9_{dy} + \beta_3 \Delta D_{dy} + \beta_4 (B) + e_{dy} \qquad (3)$$

where Δ is the difference between the two matched boards. B now becomes the specific boundary over which the two DAs are matched, rather than a board.

[8] I do not use the boundaries of Kawartha DSB or Upper Grand DSB because a) their borders do not necessarily follow the Catholic school board boundaries and b) there are very few matched DA observations.

As in the case of no differencing, I also run specifications with separate counts for public and Catholic schools and pooled dependent variables, in order to allow for separate impacts of Catholic and Public school choice:

Separated Public and Catholic school counts:

$$\Delta\ UAR_y = \beta_1\ \Delta\ C_{yp} + \beta_2\ \Delta\ C_{yc} + \beta_3\ \Delta\ G9_{dy} + \beta_4\ \Delta\ D_{dy} + \beta_5\ (B) + e_{dy} \qquad (3b)$$

<u>"Pooled" Catholic and Public Dependent Variables</u>

Total School Counts:

$$\Delta\ UAR_y = \beta_1\ \Delta\ C_{dy} * P + \beta_2\ \Delta\ C_{dy} * (1\text{-}P) + \beta_2\ \Delta\ G9_{dy} + \beta_3\ \Delta\ D_{dy} + \beta_4\ \Delta\ (B) + e_{sy} \qquad (4)$$

Separated Public and Catholic school counts:

$$\Delta\ UAR_{yp} = \beta_1\ \Delta\ C_{dyp} * P + \beta_2\ \Delta\ C_{dyp} * (1\text{-}P) + \beta_3\ \Delta\ C_{dyc} * P + \beta_4\ \Delta\ C_{dyc} * (1\text{-}P) +$$

$$\beta_5\ \Delta\ G9_{dy} + \beta_6\ D_{dy} + \beta_7\ (B) + e_{sy} \qquad (4b)$$

2.5 Results

Descriptive Statistics

Table 2-2 – Summary of Main Variables provides basic descriptive statistics for the main variables of interest. University application rates average 12 percent of high-school students. Assuming that students are roughly evenly distributed between grades 9-12, this is equivalent to an application rate of about 40% of grade 12 students. The application rate is slightly higher from public schools than Catholic schools. The average number of accessible schools from a DA (our measure of school choice/competition) is 12.4, of which 8.4 are Public high schools and 4.1 are Catholic high schools.

Table 2-3 provides evidence on the extent of variation in the accessible school count variables. About 12% of DA's can access 20 or more English Public high schools (that is, the location of the DA falls in the school's travel zone). These very high values of the school choice measure occur primarily in Toronto District School Board (i.e. downtown Toronto), as Table 4 shows that the average count is much higher in that board than any of the others.

Figures 2-2 through 2-5 provide additional illustration of the differences in choice across regions of the Greater Toronto Area. These figures show the high schools (using stars) and the postal codes (using small dots and triangles) of the students who attend those schools. Dots of the same colour indicate that the students of those postal codes all attend the same (public or Catholic – depending on which Figure) high school. Triangles indicate that the students from that postal code attend more than one high school. Comparing Figures 2-2 and 2-3 (City of Oakville) to Figures 2-4 and 2-5 (City of Toronto) demonstrates clearly demonstrates that students in downtown Toronto have considerably more choice of high school than do students in Oakville.

A key aspect of the methodology of using matched DAs across school board boundaries is that there exists a discontinuity in the likelihood that a student attends a high school outside of the area of the school board in which he/she resides. This is what provides exogenous variation in school counts when comparing DAs on wither side of a school board boundary. Table 2-5 shows that only about 1 percent of students cross school board boundaries in order to attend high school. In of itself, this is not surprising, since schools that are outside of the student's home board are likely further away. However, even when I restrict attention to the DAs in my matched samples (which, by definition, average less than 2.5 km on average from a board boundary), only just above 1 percent of public school students cross school board boundaries (and just above 3% for Catholic school students).

In Table 2-6, I compare the characteristics of DA's in Toronto to those in Peel, York and Durham, using the full dataset, and the two matched samples. Not surprisingly, the DA's become more like their cross-boundary neighbours as one moves from the unmatched (full) samples to the basic matched sample, and finally the sample which is also matched on grade 9 test scores.

The first four variables described in the Table 2-6 are those on which the DA's have been matched in the matched samples. In all four of these variables (household income, percentage of DA with a university degree, average dwelling value, and average grade 9 math score), neighbourhood averages are substantially different in the full sample, but much more closely matched in the matched sample. However, even in the sample matched on test scores, slight differences persist in average household income and math scores (the difference for math scores is just barely statistically significant). For this reason, I continue to control for these variables in the matched sample regression analysis.

Importantly, the number of accessible schools continues to be much larger in Toronto neighbourhoods than in their matched neighbourhoods in York, Peel and Durham. This is the major source of variation in school choice which drives the cross-boundary matching models, and is a direct result of the fact that students are unable to access schools located on the opposite side of a boundary to their residence.

Regression Results

Table 2-7 presents regression results for the entire sample, using the specification of Equation 1, so that the dependent variable is the total application rate for the DA. Under this basic specification, the coefficient on the total count (i.e. total of public and Catholic high schools) variable is negative and significant. When the counts are separated into public and Catholic, it is the public rate that is negative, whereas the coefficient on the Catholic school count is insignificant. This would imply that an increase in the number of accessible public schools is associated with a decrease in the university application rate for the DA.

In order to try and explain these negative signs, I conduct regressions within the largest boards separately, within each year separately, and within the main boards and each year separately. These results are found in Appendices 1 and 2. Appendix Table 2-11 (total application rate) and Appendix Table 2-14 (pooled application rate) show that, when focussing attention on the three largest boards individually, the region that comprises the Toronto District and Toronto Catholic District School Boards accounts for most of the negative results on the school count coefficients. Appendix Table 2-12 and

Appendix Table 2-13 show that all years (with the possible exception of 2000 – where the public and Catholic counts switch signs) have basically the same results as found in Table 2-7 and that each board is fairly consistent across years. It is not clear why the school counts coefficients are negative in the region of the Toronto and not elsewhere. However, as previously shown in Table 2-4, the average accessible school count is two to four times as large in the Toronto Board region as any of the other areas. It is possible that I am unable to control for certain missing variables which explain why areas with many accessible schools in downtown Toronto are associated with lower university application rates.[9]

Given the concern that the estimates in Table 2-7 (and those of Appendices 1 and 2) suffer from issues of missing variables and/or endogeneity of the school count variables and potentially omitted variables, I therefore seek to find plausibly exogenous variation in these key variables. I follow the cross-boundary matching procedure described below in order to compare similar and nearby neighbourhoods on either side of a school board boundary. Table 2-8 presents regressions results using the resulting two matched boundary samples. All variables in the regression results are specified in terms of the difference between the two matched neighbourhoods (DAs).

The first four columns of Table 2-8 present results of the basic match (i.e matching on income, property values and education levels). The final four columns (5-8) provide results from the more restrictive matching procedure (matching on test

[9] I do, of course, control for the obvious factors such as population density, parental education levels and income.

scores in addition to the three original criteria). Columns 3, 4, 7 and 8 include fixed effects for the boundary over which the DAs are matched. In all of these specifications, the significant negative signs have disappeared, although the (mostly) positive coefficients are insignificant.

Since Catholic and Public boards are of differing sizes, and thus face differing cost structures, it may also be argued that public and Catholic schools may react differently to competition (or that public and Catholic school students react differently to choice). For this reason, I run the specifications described in equations 2, 2B, 4 and 4B. Under these specifications, the application rate for each DA (the dependent variable) is disaggregated into both a public school application rate and a Catholic school application rate. I refer to these sets of regressions as “pooled” regressions, since each DA’s public and Catholic application rates are included in the regressions, and therefore each DA now represents two observations.

Table 2-9 shows the results of these pooled regressions using the entire sample. As with previous results using the entire sample, many of the coefficients are strongly negative. In particular, columns 1 and 3 show that the total count of schools negatively influences both the public and Catholic application rates. However, this seems to be primarily caused by the negative influence of the count of public schools on both public and Catholic application rates. Again, these full sample results likely suffer from endogeneity and omitted variables.

Table 2-10 shows the same regressions once I attempt to find exogenous variation in the school counts by restricting the sample to matched DAs across school board boundaries. As with the results from Table 8, the negative coefficients tend to disappear once I focus on the matched samples. In the more restrictive sample matched on test scores, there remain no statistically significant negative results. Under all specifications, the total number of accessible schools has a positive influence on the public application rate (and is significant except in the first fixed effects model). This would suggest that each additional school (whether public or Catholic) increases the application rates from public schools by about 0.11 or .12 percentage points. However, the impact on the Catholic application rate is insignificant.

When looking at the separate counts of public and Catholic schools (even numbered columns), the coefficients are negative for the effects of the public school counts on the public school application rate and Catholic school count on Catholic school application rate. However, these are not significantly different from zero once the DAs have been matched on student test scores. Interestingly, what seem to be driving the positive signs on the total counts are the cross effects. That is, the count of public schools has a positive effect (though often insignificant) on the Catholic application rate, whereas the count of Catholic schools has a consistently positive (and always significant) effect on the application rate from public schools. The point estimate on the coefficient for the test scores match suggests that each additional Catholic school (DAs on average have access to four Catholic schools) increases the application rate of public school students by 0.48 percentage points (on a base of about 10%).

5.3 Robustness Checks

As an additional test, Appendix 3 presents regressions using the matched DA samples but without the matching procedure (i.e. using the specification of equations 1 and 2). Using these border samples, like Table 2-8, Appendix Table 2-15 (dependant variable – total application rate) shows insignificant signs (as opposed to significant negative signs in Table 2-7 using the entire sample). Thus, for results using the total application rate as the dependent variable, most of the change from negative signs in Table 2-7 to insignificant positive signs in Table 2-8 was due to the change to the boundary sample rather than the matching procedure.

The pooled results (Appendix Table 2-16) give weakly positive results with coefficients roughly half the size of those in Table 2-10. Furthermore, using the sample matched on scores and board fixed effects, there remain significant negative signs. It therefore seems as though about half of the change in signs (from negatives in Table 2-9 to positive in Table 2-10) is due to focussing on the boundary sub-samples and half due to the matching procedure.

I also conduct some robustness checks on the shaping of the school travel zones (results not shown). These checks do not qualitatively change the results.

2.6 Summary and Discussion

There is a large (primarily US) literature examining the impacts of the extent of choice of institutions on educational outcomes. The typical mechanism through which this is expected to take place is that competition for students between schools will lead to increasing schooling outcomes (typically standardized test scores or wages). Other possible mechanisms exist, however, including the idea that more choice of schools allows students to find schools which better match their needs and, thus, excel.

In my research, I estimate the impact of ability to choose between high schools in the Greater Toronto Area of Ontario, Canada on the likelihood of students' application to an Ontario university. The unit of observation in the analysis is the census Dissemination Area (DA). For each DA, I establish the percentage of high school students applying to university using data from university applications and high school enrolments. I also separate the total application rate into the public application rate (i.e the rate of application of public high school students) and the Catholic application rate (i.e the rate of application of Catholic school students).

For each DA, I establish counts of high schools (totals, and separately for public and Catholic schools) that are accessible to students from that DA. I do this by first establishing a school travel zone for each school based on the actual travel patterns of its students, a method created by Gibbons et al (2009). This procedure involves starting due north of the school and creating pie-shaped wedges around it, each containing ten percent of the school's attendance. Each pie-shaped wedge ends at the distance of the student who lives at the 75th percentile distance from the school in that wedge.

I then regress the university application rates on the accessible school counts variables and a series of controls for the neighbourhood, school board and year dummies. I recognize that the accessible school counts are likely to be endogenous to the neighbourhoods and that these results are therefore likely biased.

In order to obtain exogenous variation in my school choice count variables, I use a "boundaries discontinuity" model, following a methodology similar to Gibbons et al (2009). I match otherwise similar neighbourhoods (DAs) located on either side of a school board boundary and compare differences in accessible school counts and percentages of students applying to university. This procedure hinges on the discontinuity induced by the fact that, while students are relatively free to choose from high schools within the area of their local school board, they rarely are able to cross a school board boundary. Therefore, while the matched DAs are otherwise similar in neighbourhood characteristics, they differ in terms of their number of accessible schools.

I find a small positive impact of school choice on student applications to university. However, most of the impact is in terms of cross-effects: the most robust finding is that the more Catholic high schools accessible from a DA, the better the public high schools perform. I find neither any positive effect of increases in the number of accessible public schools on the public application rate nor any positive impact of increasing the number of Catholic schools on the Catholic application rate. This suggests that a likely mechanism through which choice affects school outcomes is through competition between public and Catholic school boards, rather than between individual schools within the same board.

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7. Tables

Table 2-1 – Sample Sizes

Sample Sizes	
DAs restricted to GTA from 2000 to 2004	45,659
Observations left after matching to census data and dropping missing data	34,681
Matched DAs (match on income, education, housing values) – matched pairs	5,311
Matched DAs (add test scores of accessible schools to match) – matched pairs	3,473

Table 2-2 – Summary of Main Variables

Descriptive Statistics – Full Sample (34,681)				
	Mean	St. Dev.	Min	Max
Total University Application Rate	12.0	10.4	0	100
Public Application Rate	12.7	12.6	0	100
Catholic Application Rate	11.5	17.8	0	100
Total Accessible School Count	12.4	9.7	1	41
Accessible Public School Count	8.4	7.0	0	31
Accessible Catholic School Count	4.1	3.1	0	15
Average Household Income	79,054.1	45,376.8	0	928,844
Percentage of DA holding Bachelor's Degree	22.0	15.2	0	88.4
Average Dwelling Value	242,371.9	133,611.5	0	2,480,683
Average Gr. 9 Test Scores of Accessible Schools (from DA)	2.4	0.2	1.56	3.0

Notes: For each DA, the accessible school count is the number of high school travel zones in which the DA is located (i.e. the longitude and latitude of the DA's centroid).

Table 2-3 – Variation in Accessible School Count Variables

Distribution of DAs' Accessible School Counts								
	0	1	2-3	4-6	7-9	10-19	20-41	Total DA's
Total Accessible School Count	0	347	3,652	8,870	6,701	6,774	8337	34681
	0.0%	1.0%	10.5%	25.6%	19.3%	19.5%	24.0%	100.0%
English Public School Count	132	2,167	6,872	10,877	4,329	6,133	4171	34681
	0.4%	6.2%	19.8%	31.4%	12.5%	17.7%	12.0%	100.0%
English Catholic School Count	856	8,538	9,354	6,884	7,227	1,822	0	34681
	2.5%	24.6%	27.0%	19.8%	20.8%	5.3%	0.0%	100.0%

Notes: For each DA, the accessible school count is the number of high school travel zones in which the DA is located (i.e. the longitude and latitude of the DA's centroid).

Table 2-4 – Accessible School Counts by Board Area

Average DA Accessible School Count, by DA's Public School Board

Public School Boards		Number of DA observations	Mean travel zone count		
			Total Count	English Public	English Catholic
B66052	Toronto DSB	14167	21.6	14.5	7.1
B66060	Durham DSB	2690	4.8	3.5	1.3
B66079	Kawartha Pine Ridge DSB	292	2.4	1.4	1.0
B66095	York Region DSB	4047	5.5	3.3	2.2
B66117	Upper Grand DSB	5	2.8	1.4	1.4
B66125	Peel DSB	4859	8.9	5.5	3.4
B66133	Halton DSB	2436	6.0	4.7	1.3
B66141	Hamilton-Wentworth DSB	3470	5.5	3.9	1.5
B66150	DSB of Niagara	2715	4.6	3.3	1.2

Notes: For each DA, the accessible school count is the number of high school travel zones in which the DA is located (i.e. the longitude and latitude of the DA's centroid).

Table 2-5 – Crossing of School Board Boundaries

Percentage of Students Crossing School Board Boundaries

	English Public Boards	English Catholic Boards
All DAs sample (N=34,681)	0.8	1.3
Basic Matched Boundary Sub-sample (N=5,311)	1.2	2.7
Matched on Scores Boundary Sub-sample (N=3,473)	1.3	3.2

Table 2-6 – Comparison of Matched DAs

Comparison of matched DA's across Toronto DSB Boundary						
	Full Sample		Basic Match Sample		Match on Test Scores Sample	
	Toronto DA's	York, Peel & Durham DA's	Toronto DA's	Matched Das in York, Peel, & Durham	Toronto DA's	Matched Das in York, Peel, & Durham
Household Income	78939.87	87720.05*	75654.33	79493.39*	76934.63	80389.73*
	(55052.51)	(38287.79)	(18364.80)	(17907.13)	(8154.26)	(17687.56)
Percent of DA with BA	27.22	20.52*	22.97	22.66	24.14	23.68
	(17.33)	(12.07)	(11.04)	(10.70)	(11.09)	(10.94)
Average dwelling value	280125.10	250432.90*	254976.90	257283.80	261338.40	261306.00
	(164326.30)	(95235.47)	(56367.41)	(52607.54)	(58046.89)	(53671.45)
Average grade 9 math score	2.38	2.47*	2.47	2.55*	2.51	2.53*
	(0.16)	(0.19)	(0.20)	(0.20)	(0.20)	(0.20)
Accessible public schools	14.52	4.28*	7.02	3.09*	7.10	3.35*
	(7.04)	(1.99)	(3.60)	(1.81)	(3.49)	(1.90)
Accessible Catholic schools	7.07	2.50*	4.63	2.64*	4.61	2.78*
	(2.30)	(1.54)	(1.88)	(1.27)	(1.74)	(1.27)
Population density	5211.92	1996.11*	3557.04	1948.30*	3615.03	2058.41*
	(2791.57)	(1381.85)	(1246.86)	(1125.40)	(1200.55)	(1101.03)
Percent of DA Catholic	34.21	36.81*	32.83	36.90*	30.68	33.50*
	(17.90)	(17.01)	(16.56)	(21.17)	(15.59)	(20.06)
Percent of DA immigrant	44.51	34.79*	53.31	53.21	54.47	54.44
	(16.69)	(17.63)	(15.07)	(15.07)	(15.08)	(14.04)
N	14167	11596	2859	2859	1825	1825

Notes: An asterisk indicates that the mean for the DA's in the York, Peel, and Durham regions was significantly different (at the 5% level, 2-tailed test) from the corresponding mean for the Toronto DA's. For each DA, the accessible school count is the number of high school travel zones in which the DA is located (i.e. the longitude and latitude of the DA's centroid).

Table 2-7 – Total Application Rate Regressions, No Matching (Full Sample)

Unmatched Total Sample Regressions – Dependent Variable: Total University Application Rate				
	Basic Models		Board Area Fixed Effects	
	1	2	3	4
	Total Count	Separate counts	Total Count	Separate counts
Count of all accessible high schools	-0.0330[c]	--	-0.0399[c]	--
	(0.0090)	--	(0.0077)	--
Count of accessible public high schools	--	-0.0635[c]	--	-0.0542
	--	(0.0165)	--	(0.0538)
Count of accessible Catholic high schools	--	0.0423	--	0.0050
	--	(0.0320)	--	(0.1541)
N	34681	34681	34681	34681

Notes: Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 2-4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Table 2-8 -Total Application Rate Regressions, "Basic Matched" and "Matching on Scores" Samples

Matched Regression Results - Dep Var: Total Application Rate, Regular Travel Zone								
Dependent Variable: Total Application Rate	Basic Match				Match on Scores			
	Basic Model		Boundary Fixed Effects		Basic Model		Boundary Fixed Effects	
	1	2	3	4	5	6	7	8
	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts
Count of all accessible high schools	0.0362	--	0.0442	--	0.0165	--	0.0244	--
	(0.0354)	--	(0.0652)	--	(0.0450)	--	0.0275	--
Count of accessible public high schools	--	0.0238	--	0.0385	--	-0.0042	--	0.0132
	--	(0.0591)	--	(0.0916)	--	(0.0725)	--	(0.0812)
Count of accessible Catholic high schools	--	0.0644	--	0.0566	--	0.0620	--	0.0486
	--	(0.1058)	--	(0.0960)	--	(0.1191)	--	(0.1079)
N	5311	5311	5311	5311	3473	3473	3473	3473

Notes: Control variables are differences between matched DAs in :DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Boundary fixed effects refer to the English Public School Board boundary between the two matched DAs. Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Table 2-9 – Pooled Application Rate Regressions, No Matching (Full Sample)

Unmatched Total Sample Regressions - Dependent Variable: Pooled Application Rate

	Basic Model		Board Fixed Effects	
	1	2	3	4
	Total Count	Separate counts	Total Count	Separate counts
Total School Count on Public Application Rate	-0.0009	--	**-0.0325**[a]	--
	(0.0102)	--	(0.0173)	--
Total School Count on Catholic Application Rate	**-0.1578**[c]	--	**-0.1894**[c]	--
	(0.0112)	--	(0.0119)	--
Public School Count on Public Application Rate	--	**-0.0550**[c]	--	-0.0533
	--	(0.0203)	--	(0.1166)
Public School Count on Catholic Application Rate	--	**-0.2331**[c]	--	**-0.2313**[c]
	--	(0.0282)	--	(0.0524)
Catholic School Count on Public Application Rate	--	**0.1351**[c]	--	0.0429
	--	(0.0423)	--	(0.2466)
Catholic School Count on Catholic Application Rate	--	0.0244	--	-0.0678
	--	(0.0560)	--	(0.1205)
N	69175	69175	69175	69175

Notes: Pooled Application rate means that each DA has two observations – the application rate from Catholic school and from public schools. Count variables are then interacted with zero-one variables indicating if the observation is the Catholic or public application rate. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Table 2-10 – Pooled Application Rate Regressions, Basic Match and Match on Scores

Matched Regression Results - Dep Var: Pooled Application Rate, Regular Travel Zone								
Dependent Variable: Pooled Application Rate	Basic Match				Match on Scores			
	Basic Model		Boundary Fixed Effects		Basic Model		Boundary Fixed Effects	
	1 Total Count	2 Separate counts	3 Total Count	4 Separate counts	5 Total Count	6 Separate counts	7 Total Count	8 Separate counts
Total School Count on Public Application Rate	0.1331[c]	--	0.1449	--	0.1110[a]	--	0.1235[c]	--
	0.0435	--	0.0973	--	0.0569	--	0.0219	--
Total School Count on Catholic Application Rate	0.0176	--	0.0294	--	-0.0305	--	-0.0181	--
	0.0600	--	0.0571	--	0.0779	--	0.0697	--
Public School Count on Public Application Rate	--	-0.1693[c]	--	-0.1494	--	-0.0658	--	-0.0398
	--	0.0753	--	0.0995	--	0.0892	--	0.1030
Public School Count on Catholic Application Rate	--	0.2818[c]	--	0.3017	--	0.0607	--	0.0866
	--	0.1189	--	0.1506	--	0.1587	--	0.1393
Catholic School Count on Public Application Rate	--	0.7731[c]	--	0.7661[b]	--	0.4873[c]	--	0.4694[a]
	--	0.1323	--	0.3524	--	0.1511	--	0.2250
Catholic School Count on Catholic Application Rate	--	-0.5358[c]	--	-0.5430[c]	--	-0.2190	--	-0.2371
	--	0.1987	--	0.0754	--	0.2505	--	0.1358
N	10601	10601	10601	10601	6930	6930	6930	6930

Notes: Pooled Application rate means that each DA has two observations – the application rate from Catholic school and from public schools. Count variables are then interacted with zero-one variables indicating if the observation is the Catholic or public application rate. Control variables are differences between matched DAs in :DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Boundary fixed effects refer to the English Public School Board boundary between the two matched DAs. Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Figure 2-1 – A Typical Travel Zone – Thistletown CI (Toronto-Peel-York Boundary)

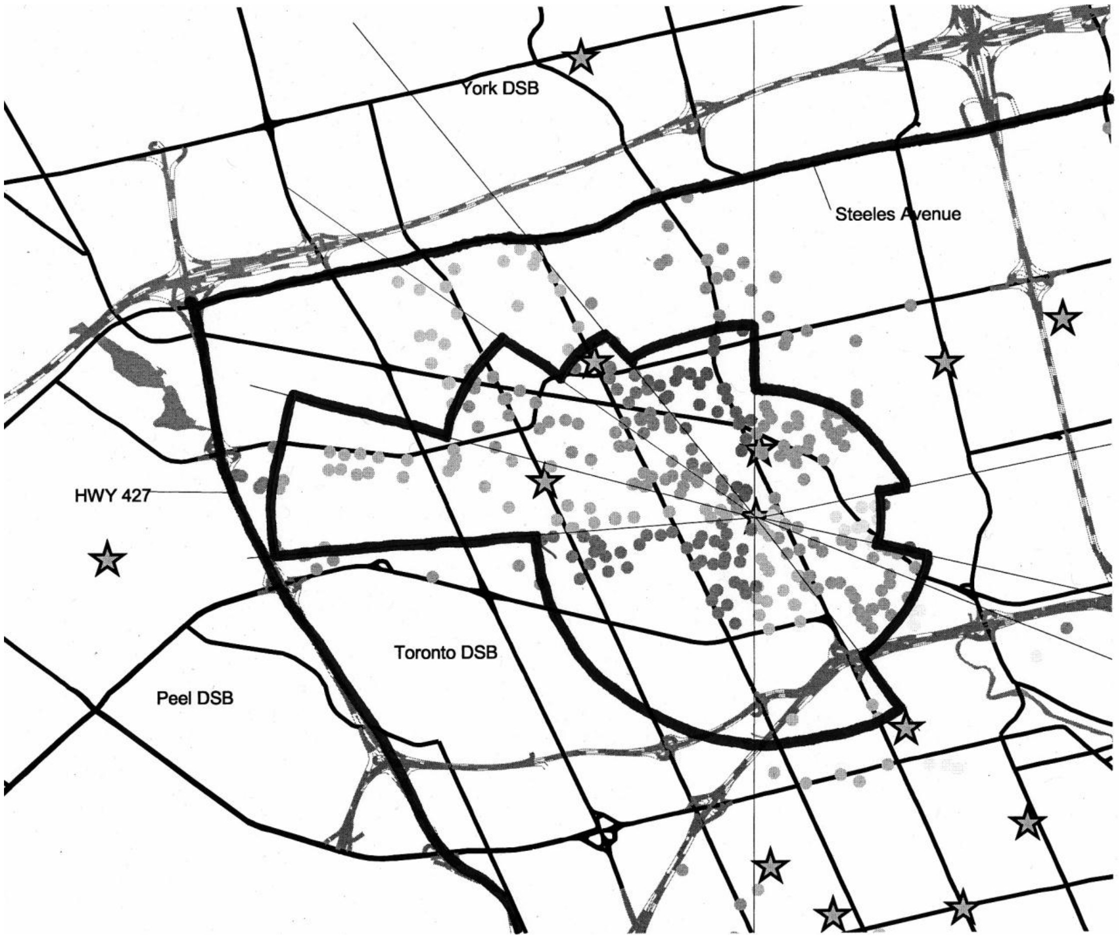


Figure 2-2 - Oakville Public High Schools and Attendance

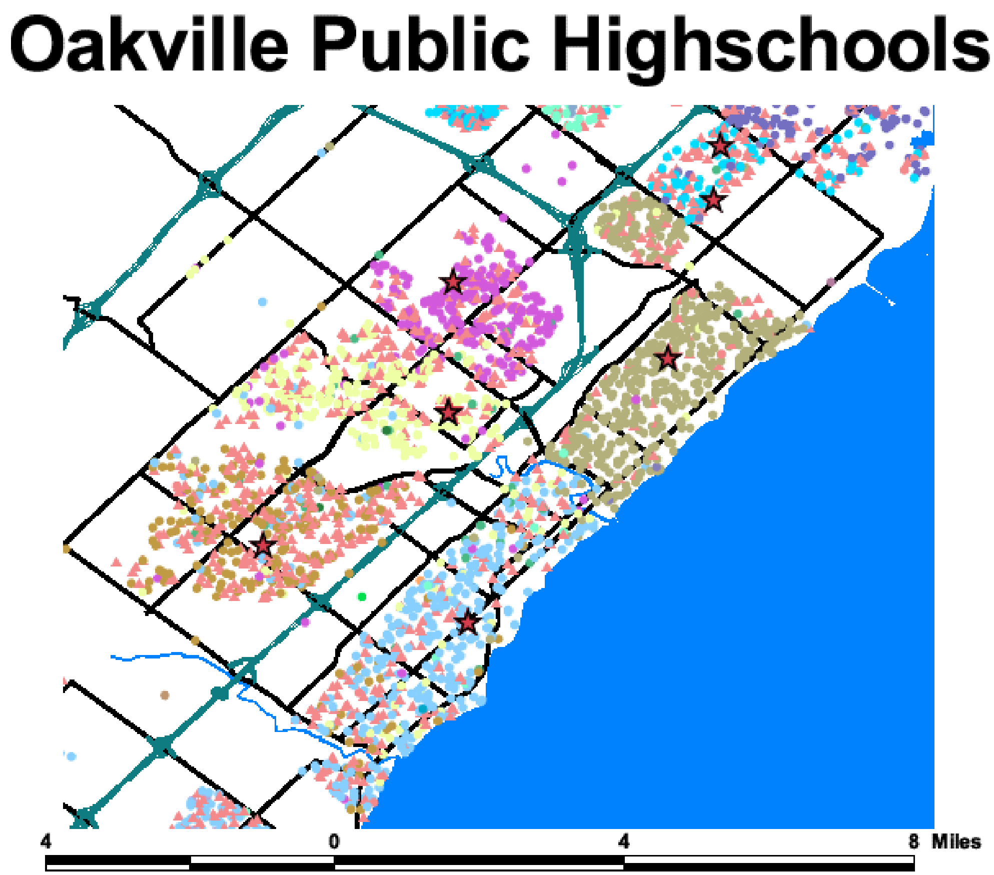


Figure 2-3 – Oakville Catholic High Schools and Attendance

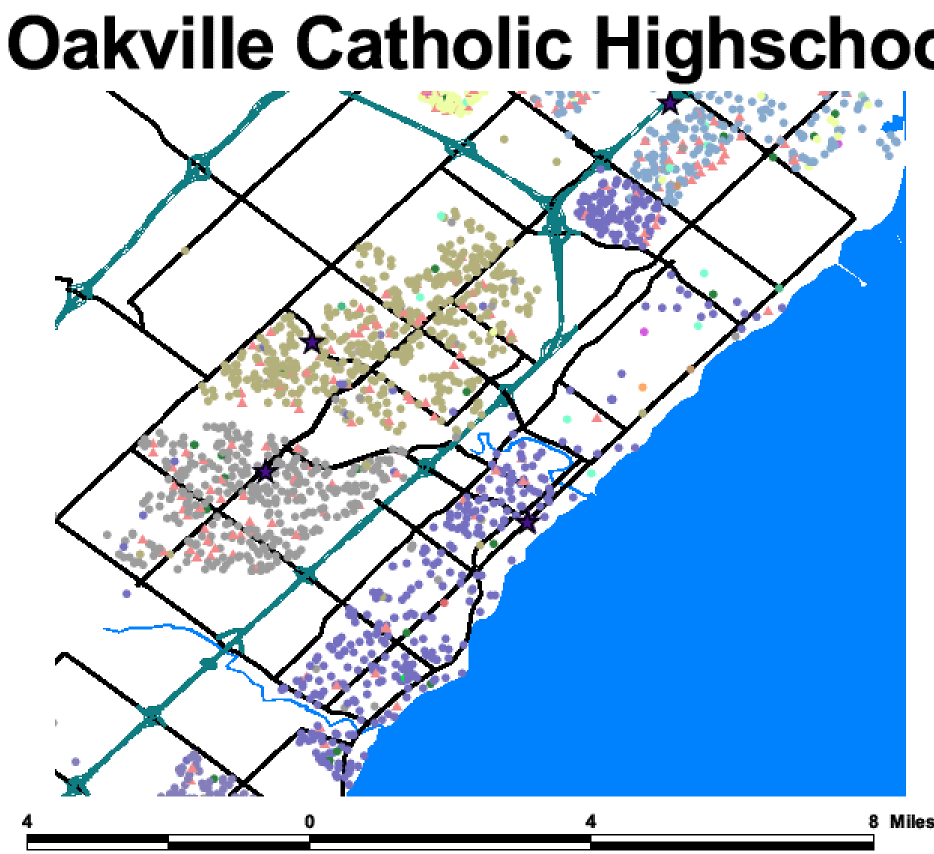


Figure 2-4 – Toronto Public High Schools and Attendance

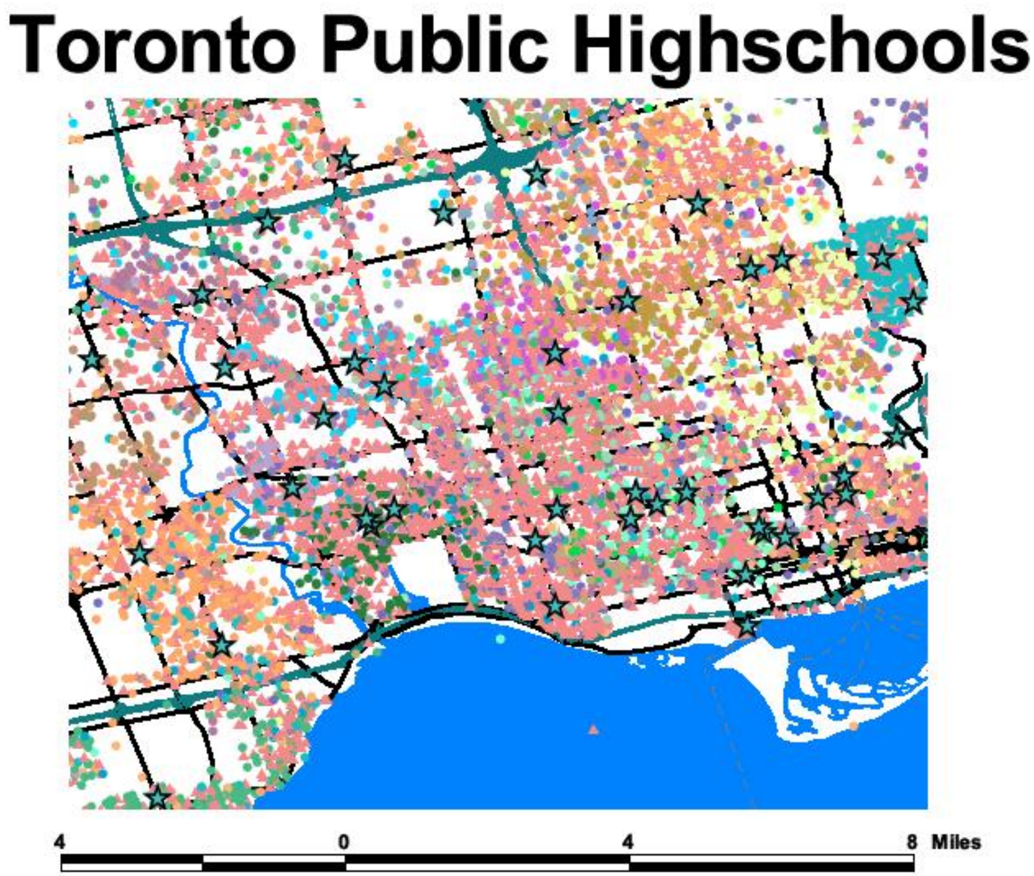


Figure 2-5 – Toronto Catholic High Schools and Attendance

Toronto Catholic High Schools

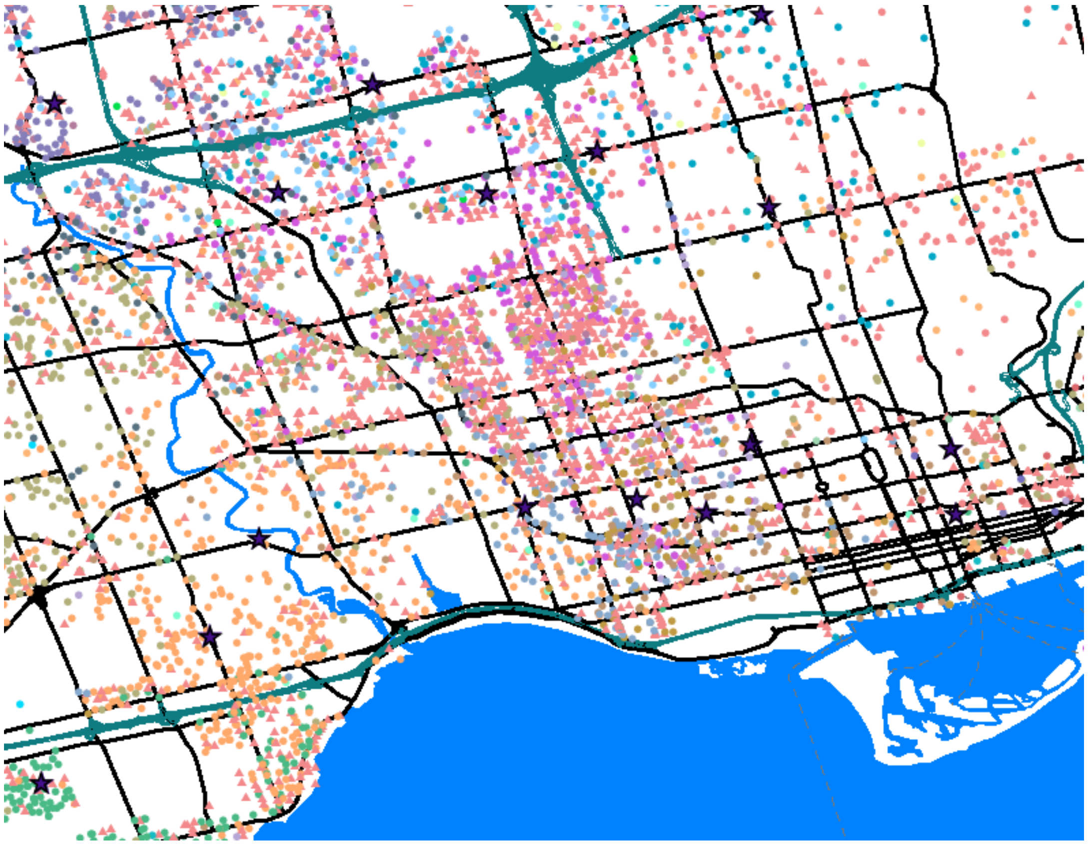
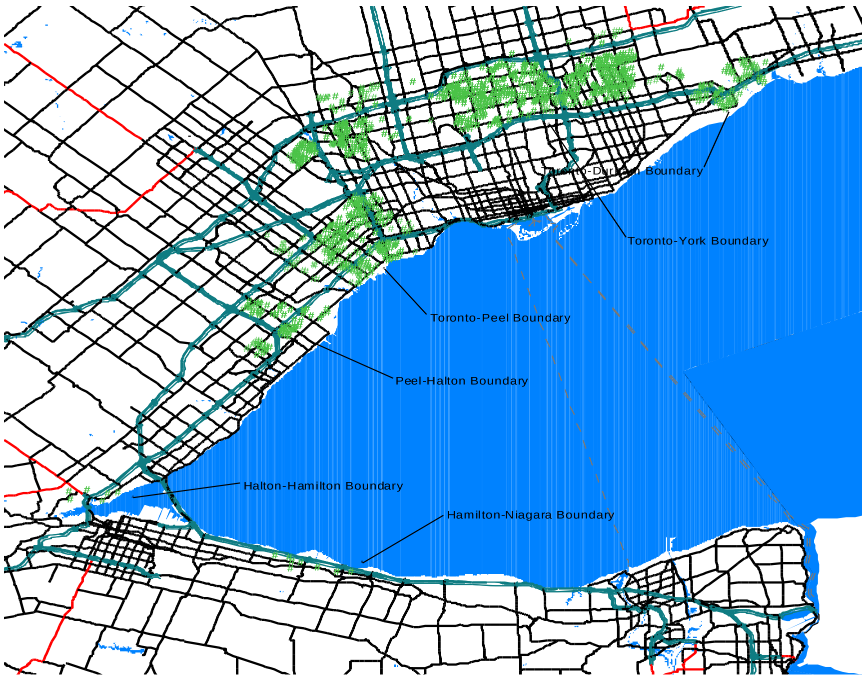


Figure 2-6 – Map of Basic Matched Sample DAs



Appendix 1

Appendix Table 2-11 – Within Board Regressions

Within Boards Regressions - Dep Var: Total Application Rate		
Within Boards - Toronto DSB	1 Total Count	2 Separate counts
Count of all accessible high schools	**-0.0218**[a]	--
	(0.0124)	--
Count of accessible public high schools	--	0.0072
	--	(0.0207)
Count of accessible Catholic high schools	--	**-0.1180**[b]
	--	(0.0513)
	14167	14167
Within Boards - Peel DSB		
	Total Count	Separate counts
Count of all accessible high schools	**0.1565**[c]	--
	(0.0391)	--
Count of accessible public high schools	--	-0.0781
	--	(0.0624)
Count of accessible Catholic high schools	--	**0.5625**[c]
	--	(0.1019)
	4859	4859
Within Boards - York DSB		
	Total Count	Separate counts
Count of all accessible high schools	0.0488	--
	(0.0866)	--
Count of accessible public high schools	--	**-0.2769**[b]
	--	(0.1102)
Count of accessible Catholic high schools	--	**0.5589**[c]
	--	(0.1457)
	4047	4047

Notes: Sample restricted to DAs within the geographic area of the given school board. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Appendix Table 2-12 – Within Year Regressions

Basic regressions - within Year - Dep var is Total Application Rate							
	Basic Model			Board Fixed Effects			
	1	2	3	4	5	6	7
	Total Count	Public Count	Catholic Count	Total Count	Public Count	Catholic Count	N
2000	**-0.086**[c]	**0.075**[b]	**-0.450**[c]	0.032	**0.081** [b]	**-0.122**[a]	6931
	(0.017)	(0.034)	(0.053)	(0.019)	(0.039)	(0.059)	
2001	0.003	**-0.121**[c]	**0.275**[c]	**-0.040**[b]	**-0.107** [b]	0.167	6927
	(0.018)	(0.034)	(0.065)	(0.015)	(0.031)	(0.091)	
2002	-0.029	**-0.064**[a]	0.061	**-0.034**[b]	-0.038	-0.020	6919
	(0.020)	(0.036)	(0.079)	(0.013)	(0.032)	(0.080)	
2003	**-0.058**[b]	**-0.162**[c]	**0.233**[b]	**-0.126**[c]	**-0.178**[c]	0.046	6936
	(0.023)	(0.042)	(0.098)	(0.025)	(0.027)	(0.049)	
2004	0.001	**-0.064**[a]	**0.164**[b]	-0.021	-0.058	0.092	6942
	(0.019)	(0.033)	(0.066)	(0.022)	(0.069)	(0.282)	

Notes: Sample restricted to the years listed. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Appendix Table 2-13 – Within Year and Board Regressions

Basic Regressions - within year and Board - Dep var: Total Application Rate												
	Toronto				Peel				York			
	1	2	3	4	5	6	7	8	9	10	11	12
	Total Count	Public Count	Catholic Count	N	Total Count	Public Count	Catholic Count	N	Total Count	Public Count	Catholic Count	N
2000	**0.059**[b]	**0.120**[c]	**-0.137**[a]	2835	0.030	-0.001	0.096	972	-0.043	-0.361	0.458	808
	(0.023)	(0.038)	(0.071)		(0.078)	(0.119)	(0.257)		(0.169)	(0.215)	(0.340)	
2001	-0.033	-0.066	0.068	2835	0.082	-0.054	**0.348**[a]	972	0.131	-0.237	**0.803**[c]	809
	(0.027)	(0.042)	(0.104)		(0.064)	(0.122)	(0.207)		(0.136)	(0.163)	(0.273)	
2002	-0.010	-0.008	-0.016	2832	0.075	0.104	0.013	970	-0.400	**-0.789**[c]	0.436	806
	(0.025)	(0.047)	(0.119)		(0.077)	(0.134)	(0.224)		(0.273)	(0.278)	(0.485)	
2003	**-0.087**[c]	**-0.141**[b]	0.099	2832	0.161	0.108	0.251	972	-0.053	-0.187	0.166	812
	(0.030)	(0.058)	(0.163)		(0.127)	(0.182)	(0.294)		(0.245)	(0.308)	(0.461)	
2004	-0.036	0.052	**-0.338**[c]	2833	**0.414**[c]	-0.005	**0.865**[c]	973	0.182	-0.025	0.409	812
	(0.028)	(0.043)	(0.114)		(0.086)	(0.153)	(0.178)		(0.183)	(0.271)	(0.258)	

Notes: Sample restricted to DAs within the geographic location of the given school boards and the years listed. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Appendix 2

Appendix Table 2-14 – Pooled Application Rate, Within Boards

Within Boards Regressions - Dep Var: Pooled Application Rate						
	Toronto		Peel		York	
	1 Total Count	2 Separate counts	3 Total Count	4 Separate counts	5 Total Count	6 Separate counts
Total Count *Public	0.0012	--	0.2073[c]	--	0.0828	--
	(0.0145)	--	(0.0447)	--	(0.1048)	--
Total Count * Catholic	-0.1814[c]	--	0.1619[c]	--	0.0261	--
	(0.0153)	--	(0.0441)	--	(0.1145)	--
Public Count * Public	--	0.0968[c]	--	-0.1558[a]	--	-0.4576[c]
	--	(0.0255)	--	(0.0829)	--	(0.1371)
Public Count * Catholic	--	-0.2588[c]	--	0.0070	--	0.3089[a]
	--	(0.0347)	--	(0.0882)	--	(0.1870)
Catholic Count * Public	--	-0.2211[c]	--	0.8215[c]	--	0.8925[c]
	--	(0.0645)	--	(0.1305)	--	(0.1908)
Catholic Count * Catholic	--	-0.0211	--	0.4443[c]	--	-0.3799
	--	(0.0788)	--	(0.1392)	--	(0.2433)
N	28199	28199	9713	9713	8081	8081

Notes: Sample restricted to DAs within the geographic area of the given school board. Pooled Application rate means that each DA has two observations – the application rate from Catholic school and from public schools. Count variables are then interacted with zero-one variables indicating if the observation is the Catholic or public application rate. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Appendix 3

Appendix Table 2-15 – Matched Sample Regressions, Unmatched

Unmatched Regressions (Basic match sample) - Dependent Variable: Total Application Rate								
	Basic Match Sample				Scores Matched Sample			
	Basic Model		Board Fixed Effects		Basic Model		Board Fixed Effects	
	1	2	3	4	5	6	7	8
	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts
Count of all accessible high schools	0.0216	--	0.0089	--	0.0224	--	-0.0129	--
	(0.0301)	--	(0.0111)	--	(0.0380)	--	(0.0074)	--
Count of accessible public high schools	--	0.0359	--	**0.0770**[b]	--	-0.0266	--	-0.0079
	--	(0.0530)	--	(0.0239)	--	(0.0669)	--	(0.0310)
Count of accessible Catholic high schools	--	-0.0085	--	-0.1360	--	0.1287	--	-0.0239
	--	(0.0875)	--	(0.0700)	--	(0.1136)	--	(0.0739)
N	5311	5311	5311	5311	3473	3473	3473	3473

Notes: Sample restricted to the same DAs of the matched sample in Table 2-8. However, no matching or differencing takes place in this model. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

Appendix Table 2-16 – Unmatched Regressions: Pooled Application Rate

Unmatched Regressions (Matched Samples) - Dependent Variable: Pooled Application Rate								
	Basic Match Sample				Scores Matched Sample			
	Basic Model		Board Fixed Effects		Basic Model		Board Fixed Effects	
	1	2	3	4	5	6	7	8
	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts	Total Count	Separate counts
Total Count *Public	**0.0904**[b]	--	**0.0530**[b]	--	**0.0859**[b]	--	0.0102	--
	(0.0361)	--	(0.0145)	--	(0.0455)	--	0.0145	--
Total Count * Catholic	-0.0211	--	**-0.0584**[c]	--	-0.0363	--	**-0.1121**[a]	--
	(0.0425)	--	(0.0122)	--	(0.0521)	--	0.0327	--
Public Count * Public	--	-0.0587	--	**-0.0517**[a]	--	-0.1105	--	**-0.1360**[b]
	--	(0.0696)	--	(0.0254)	--	(0.0878)	--	(0.0450)
Public Count * Catholic	--	**0.1886**[a]	--	**0.1956**[c]	--	0.0583	--	0.0329
	--	(0.1107)	--	(0.0342)	--	(0.1427)	--	(0.0330)
Catholic Count * Public	--	**0.3103**[c]	--	**0.1774**[a]	--	**0.4286**[c]	--	**0.2439**[a]
	--	(0.1172)	--	(0.0772)	--	(0.1520)	--	(0.1009)
Catholic Count * Catholic	--	**-0.3671**[b]	--	**-0.5001**[c]	--	-0.1577	--	**-0.3425**[b]
	--	(0.1607)	--	(0.0610)	--	(0.2148)	--	(0.1256)
N	10606	10606	10606	10606	6933	6933	6933	6933

Notes: Sample restricted to the same DAs of the matched sample in Table 2-10. However, no matching or differencing takes place in this model. Pooled Application rate means that each DA has two observations – the application rate from Catholic school and from public schools. Count variables are then interacted with zero-one variables indicating if the observation is the Catholic or public application rate. Control variables are: DA's average household income, Percentage of DA population holding a bachelors degree, Percentage of DA immigrants, Percentage of DA recent immigrants, Percentage of DA speaking English at home, Percentage of DA of Southwest Asian origin, Percentage of DA of East Asian origin, average dwelling value in DA, population density of the DA's fsa, percentage of DA of Catholic religion, year dummy variables. Board area fixed effects refer to the region of the English Public School Board in which the DA falls (the same nine listed in Table 4). Robust standard errors in parenthesis. Significance: a – significant at 10% level, b – significant at 5% level, c – significant at 1% level.

3) Choice of Ontario High Schools and Student Sorting by Ability

3.1 Introduction

Many countries provide students with choice in schooling without the student having to switch residences. Choice is provided through such channels as vouchers or tax credits for private school tuition, charter/magnet schools, or open enrolment policies. In Ontario, Canada, students have a choice between attending a school in a Public (secular) or Catholic school board.[10] They may also have choice among high schools within their chosen school board, as many boards both guarantee a place in an assigned high school near the student's residence, and allow a student to switch to another school within the board.

One rationale for these initiatives is to allow parents more easily to shift their students from schools with lower student outcomes to schools with higher student outcomes. It is assumed that parents will consider such outcomes when deciding where to send their children, and will balance them against the potential costs of switching schools. If schools (or school boards) care about maintaining or increasing their enrolment, they may compete for students by increasing the quality of their education. There are many empirical studies demonstrating that increased competition leads to

[10] In fact, student may also have the choice of a French secular or French Catholic school board. However, as the number of students attending French schools is quite small, and since most students do not meet the French-speaking requirements of the French schools, I focus only on English schools in my analysis. Likewise, I ignore private schools and students.

small but statistically significant improvements in student outcomes.[11] In addition, there is also the potential benefit that increasing the choice set for students allows them to choose school which better match their needs. This could improve outcomes even without improving the productivity of any given school.

One concern associated with increased school choice is the possibility that mainly the brightest students will move to better schools. Weaker students could therefore be left behind at poorer schools. In the US literature, this is referred to as "cream skimming." Cream skimming is likely to occur if the students who take advantage of school choice programs are the most motivated and/or most able students. If the quality of one's peers plays a positive role in one's own performance, then increasing school choice has the potential to negatively affect students left behind at poorly performing schools.

Student sorting by ability is likely to occur in two stages. First, families live in the neighbourhoods of their choice, referred to as Tiebout choice. Part of their location decision is based on securing attendance for their children at the schools they view as being of the highest quality. If families of similar income levels live together and income is positively correlated with students' ability, then students of higher ability will tend to live together. Second, given the choice of where to live, families may take advantage of policies, such as open enrolment, that allow for increased choice. These policies may increase or decrease the existing level of sorting by ability.

[11] See Belfield and Levin (2002) for a thorough US review of the impacts of increased school choice on student outcomes. Card, Dooley and Payne (2010) and Leonard (2010) study the issue for elementary schools and secondary schools, respectively, in Ontario, Canada.

In this paper, I examine the sorting of students by ability during the transition from elementary to high school. I use a panel of student test results from Ontario, Canada, and observe students in Grade 6 (and the relevant elementary school identifier) and again in Grade 9 (and the high school identifier). I therefore know the elementary school the students attended, the high school to which they would normally be assigned (according to the school board website), and the high school they actually attended. I examine the second stage of student sorting by examining the extent to which students "opt out" of the high school to which they are assigned given their residence choice. Since the transition from elementary to high school is a likely place for sorting to occur (since students typically have to switch schools anyway), this transition is an ideal time to look for evidence of sorting by ability.

I measure the extent to which students take advantage of school choice by measuring the percentage of students who "opt out" of the high school assigned for their neighbourhood. Confirming the predictions of a theoretical model, I find strong evidence that students of greater ability are more likely to opt out of their assigned high schools (and therefore take advantage of programs allowing for school choice). Students living in the wealthiest areas are less likely to opt out of their assigned schools (presumably because they can already attend school with higher quality peers or higher quality schools). I count the number of accessible schools in the neighbourhood as a measure of school choice.

However, these school choice variables are likely to be formed endogenously for several reasons, including the fact that schools are not placed randomly and their placement is strongly related to the population density in the area. As an instrumental variable strategy, I exploit the fact that students cannot cross school board boundaries when choosing a school. Distance from a school board boundary acts as an instrument for the number of accessible schools.

I find that the greater the extent of school choice, the more likely a student is to opt out. I also find weaker evidence that the impact of increased school choice is stronger on students of higher ability.

3.2 Review of the Sorting Literature

Theory

Several theoretical papers explore the possibility of sorting as a result of increased school choice. However, many of these are focused on sorting by level of family income and or race (or other measures of family socio-demographic status) rather than ability of the student. I first review two studies examining the theoretical impacts of school choice on sorting by these other factors and then focus on those studies that specifically examine sorting by ability.

Nechyba (1999) provides theoretical and computational models to examine the extent of income segregation across communities depending on the type of school system. In his models, families choose in which neighbourhoods to reside based on housing quality and access to local public schools (i.e. Tiebout choice). The quality of a school is determined by the amount of resources it receives and the average peer quality within the school. Nechyba (1999) compares three types of systems: public schools only, a mixed system of public and private schools, and a mixed system that includes publicly-funded vouchers to attend the private schools. He finds that the public school only system results in the greatest spatial income segregation since wealthy individuals have an incentive to form communities with better quality schools. A mixed system results in less spatial income segregation since wealthy individuals can send their families to private schools regardless of where they live. A system that includes vouchers induces even less income segregation as it further decreases the link between location of residence and the ability to select a preferred school.

Similarly, a theoretical model by Brunner, Cho & Reback (2010) suggests school choice programs "weaken the link between residential location and schooling options." They find that such programs can significantly reduce disparities in housing prices across school districts. Consistent with this theory, they find that districts that introduce a school choice program are likely to see increases in housing values if they are nearby to (previously inaccessible) schooling options.

Other theoretical models directly examine the link between school choice and sorting by student ability. For example, Epple and Romano (1998) provide both theoretical and computational models that predict that vouchers (i.e., increased choice of private schools) will increase sorting (across schools given the residential location decision) on both income and ability. This is because the private schools cream-skim the most able and most wealthy students. Further, their model predicts that high-ability students will benefit more from increased choice than low-ability students. However, Epple and Romano (2008) update their previous model and show that a system of vouchers need not exacerbate sorting if a) private schools are required to accept all students who present a voucher; and b) private schools must accept the voucher as the full cost of tuition.

Another theoretical model by Chakrabarti (2009) predicts that students (or their families) of higher ability and higher income will be more likely to make use of vouchers to attend private schools. This result is driven by the fact that, in the household utility functions, families/children of greater ability receive greater gains from switching to a school of higher quality than do students of lesser ability. These students are therefore the most likely to switch from their assigned public school to a private school. This is unlike the Epple and Romano (1998) model where the sorting occurs because *the private schools accept only the brightest and wealthiest students*. Chakrabarti goes on to show empirically that it is the more able students who are most likely to opt to switch to private schools in the Milwaukee School System. Chakrabarti (2009) argues that this empirical finding is as a result of students' choices and is not a result of private schools allowing entry only to the best students, since schools must accept any student with a voucher, unless oversubscribed, in which case students are chosen randomly.

Empirical Studies

My own study is an empirical examination of the issue of sorting. My sample includes eight school boards which differ substantially in terms of the amount of choice they provide their students. I use a unique panel dataset, which includes students at publicly-funded schools who write Ontario's standardized tests in Grades 6 and 9, to examine the transition of students from elementary to high school.

My study is comparable to those of Cullen, Jacob, and Levitt (2005, 2006), who examine the effects on students of open enrolment policies in the Chicago Public School Board. Cullen, Jacob and Levitt (2005) find that students taking up the program (opting out of their local school) made up roughly half of the sample and these students (i.e. those who switch schools) were more likely to graduate from high school. However, Cullen, Jacob and Levitt find that these differences are not likely caused by having switched to the new school. Rather, students who opted out were already stronger students on both observable and unobservable characteristics. This is suggestive that student sorting by ability is occurring.

Cullen, Jacob and Levitt (2006) re-examine the impacts of the Chicago Public Schools open enrolment policy by comparing student who win and do not win lotteries to attend over-subscribed schools. In spite of the fact that students who win lotteries are able to attend "better" schools in terms of higher average test scores, Cullen Jacob, and Levitt find little evidence that lottery winners themselves perform any better in traditional measures of achievement such as test scores, graduation rates, or number of earned credits. Likewise, lottery winners were no more likely to enjoy school or to trust teachers. However, they did find some evidence that lottery winners performed better in non-traditional areas such as number of arrests and discipline problems.

Urquiola (2005) studies the issue of sorting by comparing choices of parents and students at the elementary and high-school levels. Since there are typically more schools and school boards at the elementary school level, Urquiola observes the same families making school choices at two different levels of Tiebout choice. He finds that there is some evidence that increases in Tiebout choice lead to greater sorting by ability.

My study is most comparable in spirit to that of Altonji, Huang and Taber (2010), since they are also interested in the sorting of students by ability. However, they study the impacts of choice induced by the provision of vouchers to attend private schools. Altonji, Huang and Taber point out that in order for cream skimming to have any negative effect, three conditions must be fulfilled:

1. There must be some variation in students' abilities within schools.
2. Students of greater ability must be more likely to switch to private (or higher quality) schools.
3. The ability of peers must influence an individual's outcomes. That is, being surrounded by peers of higher quality positively influences the outcome of a given student.

Altonji, Huang and Taber (2010) find that all of these conditions are met in their study of the impact of vouchers on American eighth-graders, and find a small negative effect of cream skimming on the graduation rates of students remaining in public schools.

3.3 Theoretical Model

To better understand the potential implications of choice in schooling on students, I present a model adapted from Chakrabarti (2009). Chakrabarti focuses on choice as it pertains to private school vouchers. In my model, I consider the choice to move from the local assigned public school to a neighbouring public school, which I refer to as “opting out” of the assigned school. I assume there exists a set of alternative public schools with exogenously defined school qualities. That is, I leave out any competitive (or other) behaviour on the part of the schools and focus only on the choice of the students with a given set of schools to choose from.

Consider a household, which is characterized by its income (y) and ability (α), where $y \in [0,1]$, $\alpha \in [0,1]$. Further assume that income and ability are independently and uniformly distributed across households. Ability broadly captures such things as: the ability of child, the motivation of parents, parent’s education level, and parental desires for child’s education.

Each student has an assigned school with perceived quality Q_A, which he/she can attend without cost. The family can also choose to send their child to one of a set of N alternative neighbouring schools, each with exogenously determined qualities, (Q_1, Q_2, … Q_N). I assume that at least one of the alternative neighbouring schools has perceived quality greater than the assigned school (or families would never opt out of the assigned school). The quality of each school is also a broad measure, and might include: the peer group of students at the school, or the "fit" of the family at the school (e.g., a child who excels in math might prefer a school which specializes in math.).

Households gain utility from the consumption of a numeraire good, x, school quality, θ, and their ability, α, and have utility functions in the form:

$U (x, \theta, \alpha) = h(x) + \alpha\, u (\theta).$ (1)

The functions h and u are assumed to be increasing and strictly concave in x and θ, respectively. Therefore, families of greater ability have a higher marginal valuation of school quality.

If the family chooses the assigned school, their utility is therefore:

$U_A (x, \theta, \alpha) = h(y) + \alpha\, u (Q_A).$ (2)

If the family opts to attend the neighbouring school, they face both non-monetary costs (e.g., acclimatization, travel time), c_{1n}, and monetary costs (e.g., travel costs, new books, new uniforms), c_{2n}. Therefore, for a family choosing the nth neighbouring school, utility is:

$U_n (x, \theta, \alpha) = h(y - c_{2n}) - c_{1n} + \alpha\, u (Q_n).$(3)

Equilibrium – Two Schools

Consider first a model where there exist only two schools: the assigned school and one neighbouring school. A family would choose to switch from their assigned school to the neighbouring school only if their utility from choosing the neighbouring school was greater than their utility at the assigned school, $h(y - c_{2n}) - c_{1n} + \alpha\ u\ (Q_n) > h(y) + \alpha\ u\ (Q_A)$. Let the difference between the utility of choosing the neighbouring school and the utility of staying at the assigned school be D, such that:

$$D = h(y - c_{2n}) - c_{1n} + \alpha\ u\ (Q_n) - h(y) - \alpha\ u\ (Q_A). \quad (4)$$

A family will therefore switch from the assigned school iff $D>0$. It is clear that $\partial D/\partial\alpha = u\ (Q_n) - u\ (Q_A) > 0$ (since $Q_n > Q_A$), so those families/students of greater ability are more likely to switch schools. This is because families of higher ability gain more from the increase in school quality associated with switching from the assigned school to the neighbouring school.

It is likewise clear that $\partial D/\partial y = h'\ (y - c_2) - h'\ (y) > 0$ (since $h'\ (y)$ is decreasing in y and $(y - c_2) < y$). Therefore, families with greater incomes are more likely to choose to switch from their assigned school to the neighbouring school.

Equilibrium – Multiple schools

Consider next the case of multiple neighbouring schools. A family can now choose between its assigned school or from a set of neighbouring schools with a continuum of exogenously determined qualities, (Q_1, Q_2, … Q_N). I assume that the supply of these schools is also determined exogenously.

Let the neighbouring school which maximizes the family's utility have quality, Q^*, and costs of c_1^* and c_2^*. The family therefore chooses between the assigned school and the preferred neighbouring school. I assume that $Q^* > Q_A$ (or nobody would ever switch schools).

As in the example with two schools, let D_2 represent the difference in utility between choosing the optimal neighbouring school and remaining at the assigned school, such that:

$$D_2 = h\ (y - c_2^*) - c_1^* + \alpha\ u\ (Q^*) - h(y) - \alpha\ u\ (Q_A) \qquad (5)$$

Again, a family would switch from its assigned school iff $D_2 > 0$. As before, it is easy to show that $\partial D_2/\partial \alpha$ and $\partial D_2/\partial y$ are positive, indicating that those families with higher ability or higher income are more likely to choose to switch to the neighbouring school.

As the number of neighbouring schools increases, *ceteris paribus*, the choice set for the family grows, and this can only positively impact their utility of choosing the optimal neighbouring school (i.e. if a newly accessible school is preferred to the previous optimal neighbouring school). As the number of school increases then, it is natural that more families will choose to switch from their assigned school.

Furthermore, to the extent that the increased choice allows families to increase Q*,[12] it will be the families with the greatest ability who will be most likely to react to the increase in school choice. This is because $\partial D_2/\partial Q^* = \alpha\, u'\,(Q^*) > 0$ increases with the ability of the family, α.

Summary of Model Predictions

I have presented a model of school choice to examine which students are likely to opt out of their assigned local schools into neighbouring schools of higher quality. In this simple model, the school qualities are exogenously determined and I focus on the reactions of students and their families.

The model predicts that, when faced with a choice between an assigned public school (with no costs), and a neighbouring public school (of higher quality and higher direct and indirect costs), it is the families with higher income and ability who are most likely to opt to switch to the neighbouring school.

Furthermore, increases in school choice (i.e., more accessible schools) mean that more students and families will opt out of their assigned schools. The increased choice will most affect families of high ability because they are the families who can most benefit from an increase in school quality.

[12] If a new school is preferred only for its lowered costs, it attracts families of different abilities equally. That is, neither $dD_2/\delta c_{1n}$* nor $dD_2/\delta c_{2n}$* vary with α.

3.4 Institutional Context and Data

Institutional Context in Toronto, Ontario

In Ontario, two publicly-funded school boards compete for students in each jurisdiction. For example, in the city of Toronto, there exist both the Toronto District School Board (TDSB) and the Toronto Catholic District School Board (TCDSB). The boundaries of the Catholic and public school boards may or may not precisely overlap in any given jurisdiction. As of 2011, there are 31 English public school boards and 29 Catholic school boards in Ontario.[13] My study focuses on 8 Catholic and public boards in the Greater Toronto Area. At the high school level, students need not be Catholic to attend a Catholic high school. However, at the elementary level, all students attending Catholic schools must be Catholic.[14]

Students typically attend elementary school from Kindergarten to Grade 8 and high school from Grade 9 to Grade 12. Ontario students write standardized tests in math, writing and reading in Grades 3 and 6 and standardized tests in math in Grade 9.

School boards, both Catholic and public, vary in the extent to which they allow students choice of high school. Some boards, such as TDSB and TCDSB, have “optional attendance” policies which allow students to apply to attend any high school within the board. Owing to the fact that these two boards also have the greatest population

[13] In addition, there are 12 French school boards which have a relatively small attendance. I exclude these boards in my analysis since most Toronto-area students (i.e., those without French-speaking parents) are not able to attend.
[14] However, Catholic Boards vary in terms of what is acceptable proof of Catholicism.

density (and therefore more schools per square kilometre), the extent of school choice is much higher in these two boards than in others.

Data

Linked Grade 6 - Grade 9 EQAO data

To study how choice in schooling affects student decisions, I rely on a data set that links two cohorts of students in Grades 6 (in 2004 or 2005) and 9 (in 2007 or 2008). These data are available from the Education Quality and Accountability Office (EQAO), the provincial testing agency. For Grade 6, I observe the test performance on three tests (math, reading, and writing) for all students in publicly-funded schools. I also observe the elementary school at which they are registered. For students who progress normally through the education system, I then observe their test score in mathematics and the high school attended in Grade 9. Therefore, I can match the student's elementary school with their chosen high school.

In addition to test scores, the EQAO data provide a small amount of demographic information on the students themselves. This includes the student's gender and status in certain programs such as English as a second language, gifted, and special needs. I also link the student's record with data from two other sources. For each school, I link measures of enrolments and locations based on a data set of school characteristics. Finally, based on the school's postal code, I link socio-economic neighbourhood characteristics from the 2006 Census. These neighbourhoods correspond to the first three digits of the postal code, namely the forward sortation area (FSA). In my urban sample, an FSA captures an average of about 11,000 households.

School data

For each school (both elementary and high school), I have Board information on attendance by postal code (although only for the years 1999-2004). That is, for each school, I have the total number of students attending from each postal code. Using this information, I create an empirical travel zone for each school based on its actual attendance pattern, as discussed in the following section. This empirical travel zones allow me to assess the number of schools that are actually accessible to a student in a given neighbourhood (based on the fact that some of their neighbours are attending the school).

Also, I use data on the exact location of each school (latitude and longitude coordinates) in order to determine the school's distance from the school board boundaries (for my IV strategy). I do this by calculating the distance between the school's location and the location of the nearest DA in an adjacent school board.

Sample

I include in my sample students from 8 district school boards (DSBs) in the Greater Toronto Area: Toronto DSB, Toronto Catholic DSB, Peel DSB, Dufferin-Peel Catholic DSB, Durham DSB, Durham Catholic DSB, York DSB, and York Catholic DSB. In order to track the movements of the students, I include only those students who wrote both the Grade 6 (at least one of the math or reading test) and Grade 9 tests within one of the above eight boards. Restricting attention to these boards results in 119,533 students who wrote at least one of the Grade 6 tests. I drop 1,403 students who live in the rural areas of these boards (i.e., northern York and Durham) to keep the sample reasonably homogenous.

I am able to observe the transition of those students who progress normally from Grade 6 to Grade 9 in the publicly-funded Ontario system. I am therefore forced to drop 16,098 students who are observed in Grade 6 but who are not observed again in Grade 9. Students for whom I do not observe a Grade 9 match include: students moving out of province between Grade 6 and Grade 9; students who move into the private system for Grade 9; and students who skip a Grade or are held back between Grade 6 and Grade 9. The 16,098 students who do not have a Grade 9 match are substantially weaker in terms of test performance than their peers.[15] However, their scores are not significantly different from those students who write the Grade 6 test, but do not write the Grade 9 test (but for whom I can match the Grade 9 school).

I also drop the 2194 students who move out of the 8 boards between Grade 6 and Grade 9, but who had a recorded Grade 9 score in another Ontario board. These students have Grade 6 test scores that are similar to those of the rest of the sample.

[15] Students with no Grade 9 match have a mean Grade 6 math score of 2.36, which is approximately one half of a standard deviation below the mean score of 2.77 for the sample.

The final dataset contains 99,858 student-level observations from 1,013 elementary schools and 240 high schools. Each student is observed in Grade 6 (either 2004 or 2005) and Grade 9 (either 2007 or 2008).

3.5 Empirical Strategy

Estimation

The theoretical model predicts that an increase in choice/competition among schools will increase the number of students opting out of their assigned schools and that the effect will be greater on the more able students. I measure choice/competition as the number of accessible high schools from the address of the elementary school. I estimate the following equation:

$$S_i = \beta_1 C_i + \beta_2 Gr6_i + \beta_3 C_i * Gr6_i + \beta_4 Indiv_i + \beta_5 School6_i + \beta_6 Census_i + \varepsilon_i$$

where:

- S_i is the decision of individual i to switch from his/her assigned high school where 1 is assigned if the student opted out of his/her assigned high school and 0 is assigned if the student went to his/her assigned high school (see discussion below);
- C_i is the choice/competition index of individual i, measured as the number of high schools accessible to the student from his/her elementary school (based on the elementary school falling in the empirical travel zone of the high school);

- $Gr6_i$ is the Grade 6 math or reading score of individual i and is a measure of the ability of the student;
- $Indiv_i$ is a vector of individual characteristics of individual i such as gender, ESL status, Gifted Status, special ed. status, or French Immersion status;
- $School6_i$ is a vector of characteristics of the Grade 6 school of individual i such as whether the school is separate or public and in which Board it is located;
- $Census_i$ is a vector of census characteristics of the neighbourhood (fsa) surrounding the Grade 6 school, including the average income level; and
- ε_i is an independent and identically-distributed error term.

The coefficients of first three variables (β_1, β_2, and β_3) are of the most interest. Based on the theory described above, I expect the sign of all three coefficients to be positive (increase the likelihood that a student opts to move from his/her assigned school). That is, the more schools accessible to the student, the more able the student, and the greater the interaction of these two variables, the more likely the student is to opt out of his/her assigned high school.

Outcome variable – S_i - Attended Assigned School

I use a straightforward measure of whether the student went to his/her assigned school. I find the feeder elementary schools from the board websites for each high school in my sample and determine whether each student went to the high school to which he/she was assigned (based on the location of his/her elementary school). The resulting “opted out” variable is binary: 1 if the student switched to a non-assigned high school, and 0 if he/ she went to the assigned high school for his/her elementary school.

In some cases (particularly in Toronto District School Board), a given elementary school may feed more than one high school. This could be because the catchment area of the elementary school overlaps the catchment areas of more than one high school. In other cases, the school board explicitly gives students attending the elementary school the right to attend more than one high school. In the case of Toronto District School Board, students are often given the choice of their assigned high school and an assigned technical or commercial high school. I consider the student to have attended their assigned high school if he/she attends any of their assigned options. As a robustness check, I also exclude TDSB commercial and technical schools from the definition of assigned high school. This change in definition results in an additional 1,300 TDSB students counted as having opted out of their assigned schools.

In the case of Toronto Catholic District School Board, the Board does not assign a high school based on area of residence. Rather, all students living in the city of Toronto may attend any of the 32 Catholic High Schools in the city (students may or may not be on a bus line that serves their chosen school). I consider three methods of treating Catholic Schools in Toronto: counting the high school that is geographically nearest to the elementary school as the assigned school (my preferred method); counting the high school which draws the most students from the elementary school as the assigned school, and dropping the TCDSB observations altogether.

Measuring Choice / Competition - C_i

I make the assumption that elementary students live relatively close to their elementary school. Given this assumption, I measure the high school choice for each student based on the location of their elementary school. That is, I count the total number of high schools that are accessible from the address of the elementary school. A high school is defined as accessible if the address of the elementary school falls within the empirical travel zone of the high school. I use these empirical travel zones to assess the number of schools that are truly accessible to the student. By comparison, if I were to use the official travel zone of the school (i.e. the catchment area described by the board), I would find that everyone had exactly one school accessible to them. By using empirical travel zones based on actual attendance patterns, I get a more realistic picture of how many schools are accessible to a student living in a given area.

I define the empirical travel zone of a high school in a similar manner to of Gibbons et al. (2009) and used in Leonard (2010). Using the school attendance data by postal code, I generate empirical school travel zones for each high school. This method cuts the area surrounding the school into ten pie-shaped wedges, each containing ten percent of the school's enrolment (therefore the denser the school population in a given direction, the finer will be the "wedges"). The radius of each pie shaped wedge is the 75th percentile distance from the school of the students living in that wedge (using the school's actual attendance). An example of a typical travel zone is provided in Figure 1.

Using the location of the elementary school as a proxy for the residence of the student, I count the number of empirical high school travel zones that are accessible from the location of the elementary school. As described below, I control for possible endogeneity of these accessible school counts through an instrumental variables strategy, where distance from a school board boundary acts as an instrument for the number of accessible schools.

Student Ability - $Gr6_i$

I measure student ability using the Grade 6 test score of the student in both math and reading (separately). If the student wrote only one of the tests, they would be included only in that set of regressions and dropped from the other. The tests are Graded from level 0 to 4, with the following meanings provided by the EQAO:

- 4 – Achievement exceeds the provincial standard.
- 3 – Achievement meets the provincial standard.
- 2 – Achievement approaches the provincial standard.
- 1 – Achievement falls much below the provincial standard.
- 0 – Not enough for level 1.

In some specifications, I treat scores of zero as missing since students receiving a Grade this low may not have completed the entire test.[16] In most specifications, I treat

[16] These students account for 104 observations on the math test and 483 observations on the reading test. Since there are so few students with scores of zero, excluding or including them makes no difference to the results.

the variables as continuous. However, I also run specifications using a dummy variable to control for having achieved a high score with no changes to the findings.

<u>Instrumental Variable Approach</u>

The choice/competition measures described above are likely to suffer from issues of endogeneity and omitted variables. Both residential location decisions and the locations of schools are potentially endogenous. Furthermore, the number of schools in an area is closely related to the population density and potentially to other demographic variables. I therefore would like to find exogenous variation in the counts of accessible schools. In order to deal with these issues, I propose to use an instrumental variables approach.

Ontario high school students do not necessarily attend the high school that is nearest their place of residence. In practice, students have a large degree of choice in terms of the high school that they attend. Naturally, the likelihood that a given student attends a given high school decreases with the distance of that high school from the student's place of residence.

Importantly, however, the likelihood of a student attending a high school takes a very large decline if that high school is on the opposite side of a school board boundary. In fact, school board boundaries are rarely crossed by students in selecting their high schools (less than 1% of students in my sample cross board boundaries to attend their high school). This creates a discontinuity in the likelihood of attending a high school which can be exploited when conducting economic analysis.

Following Gibbons et al. (2008), I use distance from a school board boundary as an instrument for the school choice count variable. The logic is as follows: since students cannot/do not cross school board boundaries, they tend to have fewer choices of schools when they live near a school board boundary as compared to further away. For example, consider a student living just west of a school board boundary which runs north-south. The student could only choose from high schools to the west of his/her residence. In comparison, a student living in the middle of a school board could choose from schools in any direction from his/her place of residence. Given this, the distance of a student's residence from a school board boundary is expected to be positively related to the extent of choice that they have in terms of the number of accessible high schools. However, we would not expect the distance from a school board boundary to have any direct effect on the likelihood of choosing to opt out of the assigned high school. It is therefore a potentially valid instrument.

Since the average high school travel zone stretches less than 5 km from the high school, the relationship between distance from a board boundary and high school choice will decrease with distance. For example, a student who lives 40 km from the school board boundary is unlikely to have significantly more choice in high schools than one who lives only 35 km from the boundary. However, a student living right next to the boundary is significantly more restricted in their choice of high schools than a student living 5 km from the boundary. For this reason, the IV models are restricted to a sample of students residing within 5 km (and 10 km) of school board boundaries. I focus on students living within 5 km (or 10 km) on either side of the Toronto District

School Board boundary. The students therefore live in Peel DSB, York DSB, Durham DSB or Toronto DSB. These boundaries are the boundaries for both the public school boards as well as the separate school boards. When restricting the data to observations within 5 km of a school board boundary, the number of observations decreases to 28,684 from 99,858.

I continue to assume that elementary school students live relatively close to their elementary school. Therefore, I use the distance from the elementary school to the school board boundary as a proxy for the distance from the student's residence to the school board boundary.

3.6 Results

Descriptive Statistics

Table 3-1 presents descriptive statistics for the full sample on the number of students opting out of their assigned high school. As described in the methodology section, I count students as having attended their assigned high schools if they attended any of the high schools (in most cases, there is only one, but TDSB gives the right to attend an assigned commercial or technical high school) listed as assigned for the elementary school. There is a fairly significant variation in the percentage of students opting out across school boards; as few as 22% of students opt out of their assigned schools in York and Durham Catholic Boards and Durham Public Board. The two

Toronto boards have the greatest percentage of students opting out of their assigned schools, regardless of definition used.

The third column of Table 3-1 provides the percentage of students opting out of their high school by virtue of having switched denominations of their school board. That is, the student went to a public elementary school and then a Catholic high school, or vice-versa. Roughly 8% of all students change school denomination in this way. In all boards but Peel, a Catholic elementary student is more likely to switch to a public high school than a public elementary student to a Catholic high school. However, since there are many more public elementary students than Catholic, the Catholic school system is a net gainer of students at the high school level in all four board regions.

The final three columns of Table 3-1 provide the average distance between the elementary school of the student and the high school. Not surprisingly, student who opt out of their assigned high school travel further to their chosen high school. Also, since there are fewer Catholic schools in total, students who attend Catholic high schools travel farther on average than do students attending public high schools.

Table 3-2 presents a comparison of the eight school boards in my sample. The second and third columns show the average Grade 6 test scores for reading and math. There is little difference in average test scores across the eight boards. However, there is some difference in the number of students who do not write the test (column 4), with TDSB having the highest likelihood of students not writing the test. Since students who miss the test tend to be the weakest students academically, this has some potential to bias test scores. The final three columns show the counts of accessible schools by school board. As described in Section 5, a school is counted as accessible to the student if its empirical travel zone includes the address of the elementary school (since the student is assumed to live near the elementary school). Clearly, there is a large variation in school choice across the eight school boards. The most choice exists in TDSB and TCDSB, where students have access to an average of about 19 high schools. At the other end of the choice spectrum are the Durham school boards, where students have access to only three or four high schools, two or three of which are public and one Catholic.

Table 3-3 presents the level of opting out of the assigned high school by the Grade 6 math score. Students who do very well on the test (a score of 4) are more likely to have opted out, as are students who did very poorly (a score of 1). However, there are very few students who score only a 1.

Figures 3.2 and 3.3 show the level of opting out of the assigned school by the level of school choice (number of accessible schools). Figure 3.2 presents the results for the entire sample and shows a strong positive relationship between the number of accessible travel zones and the number of students opting out of their assigned schools. Figure 3.3 presents the same results within a few selected boards. The relationship is still positive, but is less strong, particularly in the Durham boards, where there is less choice.

Regression Results – Before controlling for school choice

Table 3-4 presents the results of linear probability models[17] for the likelihood of opting out of the assigned high school. In these models, I include only the ability measure of the students and not the school choice measures. In columns 2 and 4, I include fixed effects for the Grade 6 school. This requires that I drop the census variables from the regressions, which are based on the neighbourhood (fsa) surrounding the elementary school, and are therefore the same for all students at the school. For all regressions, standard errors are clustered at the level of the Grade 6 school (regardless of whether I run fixed effects).

The coefficients for both reading and writing scores have strongly significant positive coefficients indicating that the higher the ability of the student, the more likely he/she is to opt out of the assigned school.[18] This is as predicted by the theoretical model presented in Section 3.

I have information only on the average neighbourhood income and not individual or family income. This is the likely reason that the coefficient on income is strongly negative. This suggests that families living in wealthier areas are less likely to send their children elsewhere, presumably because they already consider the assigned high school to be of high quality. The theoretical model predicted that the wealthiest

[17] I have also estimated both logit and probit models with no changes to the signs or significance of coefficients.

[18] Appendix 1 shows similar regressions to Table 4 where each test score (i.e. scores of 0 through 4) enter as separate dummy variables rather than a single linear score. Clearly, students who score a two (below provincial standard) opt out less than students meeting the provincial standard (a score of 3) and students scoring a 4 (above provincial standard) opt our more. Due to small sample sizes, not much can be said about the students scoring 0 or 1 on the test.

individuals would be more likely to move from a given school. Without individual income, however, I am unable to test this hypothesis.

French immersion, ESL, Special education, and gifted students are all more likely to opt out of their assigned high schools. This is likely because they must seek out schools offering specific programming that meets their needs. Population density also plays a positive role in the likelihood of opting out of the assigned school. This is likely due to the fact that increased population density increases the number of nearby schools. I expect this coefficient to decrease once I control for the accessible school count. Finally, females are more likely to opt out of their assigned high schools than males.

Table 3-5 presents the summary of the student ability coefficients for the same regressions as Table 3-4, where the samples are restricted to students within each of the eight school boards. It becomes clear that the positive coefficients on student ability are driven primarily by observations in the school boards with the most choice (greatest accessible school counts – see Table 2). That is, the regressions for the boards of Toronto DSB, Toronto Cathoic DSB, Peel DSB, and Dufferin-Peel Catholic DSB all show positive and significant increases in the likelihood of opting out with increases in student ability. The coefficients within the two York boards and Durham Catholic are mostly insignificant. Only within Durham DSB (where there is very little school choice) are the coefficients negative. That is, within Durham DSB, students of lesser ability are more likely to opt out of their assigned high schools. This pattern of results is largely supportive of the theoretical model, which predicted that school choice would impact students of greater ability the most strongly.

Regression Results – Including (potentially endogenous) school choice variables

Table 3-6 presents results once I have added controls for the number of accessible schools. In columns 2 and 4, I also include the interaction of student ability and high school choice. The coefficient on student ability remains positive and significant in these specifications, indicating that students of greater ability are more likely to opt out of their assigned high schools.

Surprisingly, the coefficients on the number of accessible schools are insignificant. However, the interaction between student ability and school choice is positive and significant. This would suggest that increased choice impacts students of higher ability, but has an insignificant impact on those of low ability. It is important to remember, however, that nothing has yet been done to account for the potential endogeneity of the school count variables.[19]

IV Estimation Regression Results

As described in the section on Empirical Strategy, I propose an instrumental variables strategy to deal with the likely endogeneity of the accessible school counts. Since students cannot easily cross school board boundaries, the number of schools they

[19] Appendix 2 presents the same results as Table 6 within each of the eight school boards. With respect to student ability (test scores), the results are largely the same as reported in Table 5. As with Table 6, the coefficients on accessible school counts are insignificant, with the exception of Durham DSB. Likewise, most of the coefficients on the interaction between ability and school choice are insignificant.

can access decreases the closer is their residence to a boundary of a school board. I therefore use the distance from a school board boundary as an instrument for the count of accessible high schools.

Appendix Table 3-16 presents the raw correlations between the distance to the school board boundary and the number of accessible high schools from the elementary school. The table demonstrates that accessible school counts decrease with proximity to school board boundary. However, this correlation is only strong when the data is restricted to schools within a short distance from the school board boundary. This is not surprising since the average radius of a school travel zone is only 4.6 kilometres. Therefore, a students living 30 kilometres from a school board boundary is not likely to have any less choice of high schools than a student who is 35 km from the boundary. However, a student living only 1 km away from the boundary has significantly less choice than a student living 5 km away. I therefore restrict my IV estimates to a sample within 5 km of a school board boundary.

Table 3-7 through Table 3-10 present the results of this IV strategy. Table 3-7 and Table 3-9 present the first stage regression results, while Tables Table 3-8 and Table 3-10 present the second stage regressions for math and reading respectively. As one moves across the columns, I add the test scores and test scores interacted with school counts. Unfortunately, I have only one instrument (distance to school board boundary), but two potentially endogenous regressors (accessible school counts and the interaction of school counts and ability). I therefore instrument each endogenous regressor individually. I instrument for the accessible school count in the first 3 columns of Table 3-8 and first 2 columns of Table 3-10; I then instrument for the interaction term in the final column of Table 3-8 and Table 3-10. The instrument, distance from board boundary, is strongly significant in all specifications, indicating that it plays a strong role in determining the number of accessible schools.

Once the count of accessible schools is instrumented for by the distance variable, it becomes positive and significant (it was insignificant in Table 3-6). This is shown in columns 1, 2 and 3 of Table 3-8 and columns 1 and 2 of Table 3-10. The point estimates suggest that each additional accessible high school increases the likelihood of opting out by 0.6 to 1.2 percentage points. Furthermore, columns 2 and 3 of Table 3-8 and 1 and 2 of Table 3-10 show positive coefficients on student ability. These coefficients suggest that for each Grade score increase (scores from 0 to 4) on their standardized test, a student becomes about 2 percentage points more likely to opt out of their assigned school.

However, when I add the interaction term between ability and the accessible school counts (Table 3-8, column 3 and Table 3-10, column 2), the coefficient becomes negative (it was positive in Table 3-6). Note, however, that I still have not instrumented for this potentially endogenous interaction term.

In the final columns of Table 3-8 and Table 3-10, I use the distance variable as an instrument for the interaction term *instead of* the accessible school count. This results in the coefficient on the interaction term returning to a positive and significant sign.

However, the school count and ability coefficients both turn negative in this specification.

Summary of Regression Results

To summarize, I have found a positive and significant coefficient for the student ability variable (whether using math or reading test scores) in all regression specifications. This is strongly supportive of the theoretical model, which predicted that students of greater ability would be more likely to opt out of their assigned schools.

With respect to accessible school counts (my measure of school choice), coefficients are insignificant using basic OLS regressions. However, once I use my instrumental variables strategy (where distance from school board boundary instruments for number of accessible schools), the coefficients on accessible school counts become positive and significant. This is also in accordance with the theoretical model, which suggested that having more school choice would make individuals more likely to opt out of their schools.

Finally, the interaction term between student ability and school choice is positive in the basic OLS regressions. When using the IV strategy (instrumenting for the number of accessible schools), it becomes negative. However, when I use the instrument for the interaction term (instead of the accessible school count), the interaction term again becomes positive and significant. This implies that an increase in school choice has a greater impact on students of greater ability.

Sensitivity Checks

I test the robustness of my results to several different changes in specification. I first check the sensitivity of the IV regression results to changes in the 5km restriction on the distance from the board boundary (see Appendix 4). The results are robust to small changes in the distance restriction, with no changes in sign or significance in the range of 4 to 9 km. However, once the distance is extended to 10 km, the school choice coefficients start to become statistically insignificant. These results are shown in Appendix 4. It is not surprising that the results become less strong as the distance from the board boundary increases. As is shown in Appendix Table 3-16, the correlation between this distance and the number of accessible schools declines as the distance from a school board boundary increases. Therefore, the instrument becomes weaker as the distance increases.

In Appendix Table 3-13, I have also specified the ability variable as separate dummy variables for each possible score (i.e. instead of entering linearly. This has no qualitative impact on the results.

Finally, I test the two alternative definitions of the assigned school for the Toronto DSB and Toronto Catholic DSB. The alternative definition for the Toronto DSB is to exclude assigned commercial and technical high schools from the definition of assigned school. Regression results are robust to this alternative definition, although the coefficient on the student ability variable is slightly smaller (although still positive and strongly significant). The alternative definition in Toronto Catholic DSB is to define the assigned school for a given student as the most attended Catholic high school for students coming from the same elementary school as the student. The coefficients on both the student ability and choice variables were insignificant in the Toronto Catholic DSB in both the original definition and the alternative definition of the assigned school. As a result, changing definitions has no impact on the overall results. Appendix 5 compares results using the two definitions for the TCDSB and from specifications which drop the TCDSB entirely.

Where do the students go when opting out?

In the analysis above, I have shown that it is the more able students who are most likely to make use of provisions to allow choice in the high school they attend. The next logical question is: where do they go? In particular, it is important to know whether these students are opting out of their schools in order to attend schools where student outcomes are better.

In Table 3-11 (math scores) and Table 3-12 (reading scores), I attempt to shed some light on the issue of where students who opt out end up. The tables rank each school in order of the percentage of the student body that has opted out (i.e., comes from outside the official catchment area). I assign schools to terciles within each school board: schools with low, medium, and high percentages of out-of-catchment area students. These Tables show that students at schools that draw the most out-of-catchment students (Tercile 3 school) have higher test scores than students at Tercile 2 schools. Results for Tercile 1 schools (low percentage of out-of-catchment students) are mixed; in half of the boards, the Tercile 1 schools have higher average Grades than the Tercile 2 schools. However, in most cases, the Tercile 1 schools have lower average Grades than the Tercile 3 schools.

The final two columns of test scores show test results separately for local and "switching" (students from out-of-catchment area) for Tercile 3 schools. The intent was to establish whether the schools which draw the most students (switchers) from out-of-catchment area would have been the schools with the highest test scores before the arrival of the switchers. In at least half of boards, there is no significant difference in test scores between the switchers and local students. In most cases, therefore, we can safely conclude that the schools attracting the most students are those which had the strongest students, even before the addition of strong students who opt to attend the schools.

3.7 Summary and Discussion

Increased school choice has the potential to positively affect students through increased competition between schools, or simply by allowing for a better match between students and schools. However, if it is the brightest students who switch from weaker to better schools, this has the potential to leave weaker students behind at weaker schools. If the ability of a student's peer group impacts his/her own learning, increased school choice could potentially hurt weaker students.

In this paper, I examine the extent to which it is students of higher ability who are more likely to make use of increases in the extent of school choice. I focus on the unique context of Ontario, Canada, where two publicly-funded school boards compete for students in each jurisdiction. I examine differences in school board policies with respect to open enrolment and differences in population density, which together lead to large differences in the number of high schools accessible to a student across (and within) school boards. I examine the transition from elementary to high school using a linked file of Grade 6 (elementary) and Grade 9 (high school) test results. Given the elementary school of the student, I infer the high school to which the student would have normally been assigned. I then examine the extent to which students "opt out" of their assigned schools.

A theoretical model predicts that students of greater ability will be more likely to opt out of their assigned school, since they can benefit more than others by attending a school of higher quality. Not surprisingly, the model also predicts that an increase in school choice (i.e., the number of accessible schools) increases the likelihood that a given student will opt out of his/her assigned school. This effect is predicted to be strongest on students of the greatest ability. Finally, the model predicts that, within a given neighbourhood, it is higher income students who are the most likely to opt out of their assigned schools.

I find strong empirical support for the first two model predictions and somewhat weaker support for the third. I find that it is the more able students (as measured by

Grade 6 reading and math scores) who are the most likely to opt out of their assigned schools. Furthermore, I find that the more schools that are accessible (either because of open enrolment policies or because of proximity to more schools), the more likely the student is to opt out. Finally, I find some evidence that this choice effect is stronger on the students of greater ability. That is, the interaction effect between student ability and school choice is positive.

I am unable to test directly the fourth prediction of the theoretical model: that the higher income families in a given neighbourhood will be more likely to opt out of their assigned schools, since I do not observe family income. I do observe average neighbourhood income. However, the coefficient on this variable is strongly negative, indicating that people living in wealthier neighbourhoods are less likely to send their children elsewhere for school. This is likely because the schools in the wealthier neighbourhoods are viewed as already being of higher quality.

Finally, I show descriptive evidence that students who opt out end up going to schools with higher average standardized test scores. More specifically, I show that the schools that are attracting the most students are those whose students have the highest test scores.

Overall, the evidence suggests that increasing choice of high schools decreases the heterogeneity of students within a given high school, as it is the brightest students who are most likely to leave schools with weaker peers to join schools with stronger peers. I leave untouched, however, whether this will have a positive or negative impact on students. If peer effects are important, decreased within-school heterogeneity of student ability has the potential to be negative for weaker students left behind at weaker schools. On the other hand, it is possible that over time, schools could become specialized in teaching weaker students, and students could benefit from choosing a school tailored to their ability level.

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Tables

Table 3-1 - Number of Students “Opting Out of their Assigned High Schools

Number of Students Attending their Assigned High Schools and Average Distance between Elementary and High Schools						
	Number of Students			Average Distance (km) from Elementary School to High School		
School Board (at grade 6)	Total Students	Went to Other Than Assigned HS	Switch denominations	All Students	Went to Assigned HS	Went to Other HS
Dufferin Peel Catholic DSB	10,616	2,687	675	4.99	3.69	8.82
		25.3%	6.4%	(5.83)	(3.79)	(8.50)
Peel District School	16,726	7,217	2,367	4.08	1.46	7.53
		43.1%	14.2%	(6.21)	(1.13)	(8.16)
Durham Catholic DSB	3,497	775	373	3.63	2.43	7.82
		22.2%	10.7%	(5.75)	(2.16)	(10.52)
Durham DSB	8,300	1,882	416	3.18	1.73	8.14
		22.7%	5.0%	(6.34)	(1.81)	(11.60)
Toronto Catholic DSB	11,410	8,148	856	5.51	2.05	6.89
(nearest school)		71.4%	7.5%	(6.10)	(1.64)	(6.66)
Toronto Catholic DSB	11,410	6,687	856	5.51	3.08	7.22
(most attended school)		58.60%	7.5%	(6.10)	(2.47)	(7.22)
Toronto DSB	29,728	14,971	1,676	4.44	1.22	7.61
(exclude comm/tech)		50.4%	5.6%	(6.75)	(0.80)	(8.34)
Toronto DSB	29,728	13,671	1,676	4.44	1.33	8.09
(include comm/tech)		46.0%	5.6%	(6.75)	(0.96)	(8.56)
York Catholic DSB	6,778	1,497	651	3.78	2.57	8.05
		22.1%	9.6%	(4.79)	(1.89)	(8.24)
York Region DSB	12,803	3,808	807	4.14	2.18	8.77
		29.7%	6.3%	(7.18)	(4.24)	(10.01)
Total	99,858	40,985	7,821	4.34	2.02	7.68
		41.0%	7.8%	(6.39)	(2.59)	(8.43)

Notes: Standard deviations in parentheses. Assigned High School means the high school to which an elementary school feeds its students (based on its address). If the catchment area of the elementary school overlaps more than one high school catchment area, students attending either high school are counted as having gone to their assigned high school. In the case of Toronto Catholic DSB, students are eligible to attend all Catholic high schools in the board (there are no assigned schools). I therefore use the closest high school to the elementary school as the assigned school or the high school to the most students from the elementary school attended.

Table 3-2 – Grade 6 School Board Information

Grade 6 School Board Information

	Number of Students / Number of Elementary Schools	Gr 6 Math Scores (if >0)	Gr 6 Reading Scores (if >0)	Number of missing or zero math scores / reading scores	Average Total Accessible High Schools	Average Accessible Public High Schools	Average Accessible Catholic High Schools
Dufferin Peel Catholic DSB	10,616	2.70	2.77	107	8.67	4.75	3.92
	112	(0.71)	(0.67)	130	(3.64)	(2.02)	(2.06)
Peel District School	16,726	2.73	2.72	139	8.46	4.83	3.63
	84	(0.75)	(0.71)	219	(3.68)	(2.03)	(2.13)
Durham Catholic DSB	3,497	2.71	2.75	49	3.58	2.30	1.28
	41	(0.69)	(0.66)	52	(1.54)	(1.29)	(0.74)
Durham DSB	8,300	2.70	2.74	239	4.02	2.78	1.24
	95	(0.70)	(0.67)	261	(1.59)	(1.45)	(0.77)
Toronto Catholic DSB	11,410	2.66	2.66	292	18.91	12.25	6.66
	167	(0.76)	(0.72)	323	(7.93)	(6.15)	(2.37)
Toronto DSB	29,728	2.77	2.73	1124	18.98	12.66	6.33
	313	(0.79)	(0.73)	1368	(8.03)	(6.46)	(2.25)
York Catholic DSB	6,778	2.91	2.90	146	4.38	2.35	2.02
	75	(0.71)	(0.65)	152	(1.61)	(1.24)	(1.06)
York Region DSB	12,803	2.96	2.86	366	5.01	2.85	2.16
	126	(0.69)	(0.65)	417	(1.78)	(1.30)	(1.14)
Total	99,858	2.77	2.75	2462	11.55	7.32	4.23
	1013	(0.75)	(0.70)	2922	(8.48)	(6.19)	(2.77)

Notes: The number of accessible schools is defined as the count of accessible high school travel zones in which a given elementary school falls. A high school is defined as accessible if the location of the elementary school falls within the empirical travel zone of the high school. Standard deviations in parentheses.

Table 3-3- Opting Out by Grade 6 Math Score

Percentage of Students Opting Out of Assigned High School, by Grade 6 Math Score

Grade 6 Math Score	Total Students	Went to Other HS
Level 1	4,884	2,061
	4.9%	42.2%
Level 2	26,280	10,228
	26.3%	38.9%
Level 3	52,570	20,293
	52.6%	38.6%
Level 4	13,662	6,003
	13.7%	43.9%
Score is missing (didn't write) or zero	2,462	1,100
	2.5%	44.7%
Total	99858	39,685
	100.0%	39.7%

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB.

Table 3-4 – Linear Probability for Likelihood of Opting Out

Linear Probability Regressions for Likelihood of Opting out of Assigned School

VARIABLES	(1) Math Scores	(2) Math scores – with Gr 6 school FE	(3) Reading Scores	(4) Reading scores – with Gr 6 school FE
Gr. 6 Math Score	0.018***	0.025***	--	--
	(0.004)	(0.003)	--	--
Gr. 6 Reading Score	--	--	0.020***	0.026***
	--	--	(0.004)	(0.003)
<u>Gr. 6 Individual Characteristics</u>				
Female	0.035***	0.033***	0.031***	0.028***
	(0.004)	(0.004)	(0.004)	(0.004)
ESL Student	0.025**	0.026**	0.032**	0.033***
	(0.012)	(0.010)	(0.013)	(0.010)
Gifted Student	0.141***	0.116***	0.139***	0.115***
	(0.038)	(0.031)	(0.038	(0.031)
Special Ed. Student	0.023***	0.032***	0.026***	0.034***
	(0.009)	(0.008)	(0.009)	(0.008)
French Immersion Student	0.279***	0.189***	0.279***	0.187***
	(0.045)	(0.047)	(0.045)	(0.047)
<u>Neighbourhood Characteristics (FSA)</u>				
Average Household Income ($1000)	-0.001***	--	-0.001***	--
	(-0.000)	--	(0.000)	--
% of population without HS diploma	0.005*	--	0.005*	--
	(0.003)	--	(0.003)	--
% of population with Bachelor's or higher	0.003	--	0.003	--
	(0.002)	--	(0.002)	--
% of population immigrant	0.007***	--	0.007***	--
	(0.002)	--	(0.002)	--
% of population with English as first language	0.006***	--	0.006***	--
	(0.002)	--	(0.002)	--

% of population southwest Asian origin	-0.000	--	-0.000	--
	(0.001)	--	(0.001)	--
% of population east Asian origin	-0.001	--	(0.001)	--
	(0.001)	--	(0.001)	--
Population density (1000/ km^2)	0.014***	--	0.014***	--
	(0.004)	--	(0.004)	--
<u>Board Dummies</u>				
Dufferin-Peel Catholic DSB	-0.134***	--	-0.136***	--
	(0.022)		(0.022)	--
Peel DSB	0.020	--	0.020	--
	(0.028)	--	(0.028)	--
Durham Catholic DSB	-0.097**	--	-0.097**	--
	(0.043)	--	(0.043)	--
Durham DSB	-0.098***	--	-0.099***	--
	(0.030)	--	(0.030)	--
Toronto Catholic DSB	0.253***	--	0.252***	--
	(0.022)	--	(0.022)	--
Toronto DSB	Omitted	--	--	--
	--	--	--	--
York DSB	-0.053**	--	-0.053**	--
	(0.025)	--	(0.025)	--
York Catholic DSB	-0.103***	--	-0.104***	--
	(0.026)	--	(0.026)	--
Constant	-0.519*	0.297***	-0.511*	0.295***
	(0.290)	(0.009)	(0.292)	(0.008)
Observations	95,989	97,041	95,904	96,958
R-squared	0.123	0.01	0.123	0.01
Number of Grade 6 Schools		1,013		1,013

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3-5- Linear Probability Models, Within School Boards

Summary Results of Linear Probability Regressions for Likelihood of Opting Out of Assigned School, within School Boards

	Coefficients for Math Scores		Coefficients for Reading Scores	
	Basic OLS	OLS with Gr. 6 School Fixed effects	Basic OLS	OLS with Gr. 6 School Fixed effects
Dufferin-Peel Catholic DSB	0.022**	0.025***	0.031***	0.034***
	(0.010)	(0.008)	(0.010)	(0.009)
Peel DSB	0.026***	0.032***	0.033***	0.038***
	(0.008)	(0.007)	(0.009)	(0.008)
Durham Catholic DSB	-0.011	-0.002	-0.018	-0.012
	(0.011)	(0.010)	(0.011)	(0.010)
Durham DSB	-0.040***	-0.025***	-0.042***	-0.030***
	(0.010)	(0.008)	(0.011)	(0.008)
Toronto Catholic DSB	0.004	0.015*	0.014	0.025***
	(0.011)	(0.007)	(0.010)	(0.007)
Toronto DSB	0.041***	0.050***	0.036***	0.046***
	(0.007)	(0.005)	(0.006)	(0.005)
York DSB	0.017**	0.012	0.005	0.005
	(0.008)	(0.009)	(0.009)	(0.009)
York Catholic DSB	-0.010	-0.009	0.003	0.002
	(0.008)	(0.008)	(0.008)	(0.007)

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3-6 – Linear Probability Models Adding School Choice Variables

Linear Probability Regressions for Likelihood of Opting Out of Assigned School Including School Choice Variables

VARIABLES	(1) Math scores	(2) Math scores with interaction	(3) Reading scores	(4) Reading scores with interaction
Accessible High School Count	0.001	0.002	0.001	-0.002
	(0.001)	(0.002)	(0.001)	(0.002)
Gr. 6 Math Score	0.018***	0.005	--	--
	(0.004)	(0.006)	--	--
Gr. 6 Reading Score	--	--	0.020***	0.005
	--	--	(0.004)	(0.006)
School Count * Test Score	--	0.001**	--	0.001***
	--	(0.000)	--	(0.000)
<u>Gr. 6 Individual Characteristics</u>				
Female	0.035***	0.035***	0.031***	0.031***
	(0.004)	(0.004)	(0.004)	(0.004)
ESL Student	0.026**	0.025**	0.032***	0.032***
	(0.012)	(0.012)	(0.012)	(0.012)
Gifted Student	0.139***	0.139***	0.138***	0.138***
	(0.038)	(0.038)	(0.038)	(0.038)
Special Ed. Student	0.023***	0.023***	0.026***	0.025***
	(0.009)	(0.009)	(0.009)	(0.009)
French Immersion Student	0.278***	0.278***	0.278***	0.277***
	(0.045)	(0.045)	(0.045)	(0.045)
<u>Neighbourhood Characteristics (FSA)</u>				
Average Household Income ($1000)	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
% of population without HS diploma	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
% of population with Bachelor's or higher	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)

% of population immigrant	0.007***	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
% of population with English as first language	0.006**	0.006**	0.006**	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)
% of population southwest Asian origin	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
% of population east Asian origin	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Population density (1000/ km^2)	0.013***	0.013***	0.013***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)
<u>Board Dummies</u>				
Dufferin-Peel Catholic DSB	-0.127***	-0.126***	-0.129***	-0.128***
	(0.022)	(0.022)	(0.022)	(0.022)
Peel DSB	0.027	0.028	0.026	0.027
	(0.028)	(0.028)	(0.028)	(0.028)
Durham Catholic DSB	-0.087**	-0.086*	-0.087**	-0.085*
	(0.044)	(0.044)	(0.044)	(0.044)
Durham DSB	-0.088***	-0.087***	-0.089***	-0.088***
	(0.031)	(0.031)	(0.032)	(0.032)
Toronto Catholic DSB	0.253***	0.254***	0.253***	0.253***
	(0.022)	(0.022)	(0.022)	(0.022)
Toronto DSB	--	--	--	--
	--	--	--	--
York DSB	-0.042	-0.040	-0.043	-0.040
	(0.026)	(0.026)	(0.026)	(0.026)
York Catholic DSB	-0.092***	-0.089***	-0.097***	-0.090***
	(0.028)	(0.028)	(0.028)	(0.028)
Constant	-0.479	-0.448	-0.471	-0.434
	(0.296)	(0.296)	(0.298)	(0.296)
Observations	95,989	95,989	95,904	95,904
R-squared	0.123	0.123	0.123	0.093

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3-7 IV First Stage Regressions, Math

First Stage Regression – Linear probability with IV Regressions Using Distance to Board Boundary as Instrument – Math Scores

VARIABLES	(1) Accessible High School Count	(2) Accessible High School Count	(3) Accessible High School Count	(4) Accessible High School Count * Ability
Accessible High School Count	--	--	--	2.686***
	--	--	--	(0.009)
Gr. 6 Math Score	--	-0.098***	-3.001***	10.347***
	--	(0.025)	(-0.015)	(0.037)
School Count * Test Score	--	--	0.288***	--
	--	--	(0.001)	--
<u>Gr. 6 Individual Characteristics</u>				
Female	0.038	0.037	0.006	0.008
	(0.036)	(0.037)	(0.018)	(0.053)
ESL Student	0.047	-0.010	-0.048	0.157
	(0.076)	(0.084)	(0.040)	(0.122)
Gifted Student	0.755***	0.870***	0.175***	0.079
	(0.130)	(0.139)	(0.067)	(0.202)
Special Ed. Student	(0.122)	(0.162)*	-0.130***	0.324**
	(0.082)	(0.090)	(0.043)	(0.130)
French Immersion Student	-0.230**	-0.200**	0.089*	-0.467***
	(0.096)	(0.096)	(0.046)	(0.140)
<u>Neighbourhood Characteristics (FSA)</u>				
Average Household Income ($1000)	-0.024***	-0.023***	-0.011***	0.020***
	(0.002)	(0.002)	(0.001)	(0.003)
% of population without HS diploma	0.506***	0.509***	0.130***	-0.050***
	(0.012)	(0.012)	(0.006)	(0.018)
% of population with Bachelor's or higher	0.449***	0.450***	0.090***	0.041***
	(0.009)	(0.009)	(0.004)	(0.014)
% of population immigrant	-0.059***	-0.056***	-0.007*	-0.021*
	(0.008)	(0.008)	(0.004)	(0.012)

% of population with English as first language	-0.061***	-0.059***	0.010***	-0.081***
	(0.008)	(0.008)	(0.004)	(0.012)
% of population southwest Asian origin	-0.025***	-0.026***	-0.004**	-0.008
	(0.003)	(0.003)	(0.002)	(0.005)
% of population east Asian origin	0.018***	0.019***	0.012***	-0.026***
	(0.003)	(0.003)	(0.001)	(0.004)
Population density (1000/ km^2)	0.347***	0.342***	0.033***	0.156***
	(0.015)	(0.015)	(0.007)	(0.022)
<u>Board Dummies</u>				
Dufferin-Peel Catholic DSB	-3.182***	-3.170***	-0.690***	-0.103
	(0.093)	(0.093)	(0.045)	(0.138)
Peel DSB	-4.404***	-4.372***	-0.665***	-1.139***
	(0.072)	(0.073)	(0.037)	(0.113)
Durham Catholic DSB	-4.349***	-4.348***	-1.132***	0.504*
	(0.157)	(0.158)	(0.076)	(0.233)
Durham DSB	-4.778***	-4.771***	-1.257***	0.607***
	(0.125)	(0.127)	(0.062)	(0.190)
Toronto Catholic DSB	0.283***	0.282***	0.096***	-0.111
	(0.053)	(0.054)	(0.026)	(0.079)
Toronto DSB	Omitted	--	--	--
	--	--	--	--
York DSB	-5.106***	-5.148***	-0.529***	-2.222***
	(0.068)	(0.069)	(0.036)	(0.110)
York Catholic DSB	-6.284***	-6.277***	-0.950***	-1.648***
	(0.089)	(0.090)	(0.046)	(0.142)
Constant	-6.944***	-7.080***	4.994***	-22.932***
	(1.098)	(1.114)	(0.532)	(1.622)
Distance to Board Boundary	1.985***	1.976***	0.392***	0.197***
	(0.015)	(0.015)	(0.009)	(0.028)
Observations	28,527	27,781	27,781	27,781
Adjusted R-squared	0.7239	0.7229	0.9371	0.9421

Table 3-8 – IV Second Stage Regressions, Math

Second Stage Regression - Linear probability with IV Regressions Using Distance to Board Boundary as Instrument – Math Scores

VARIABLES	(1) Instrument for School Choice	(2) Instrument for School Choice – add ability	(3) Instrument for School Choice – add choice*ability	(4) Instrument for Choice * Ability
Accessible High School Count	0.013***	0.013***	0.058***	-0.312***
	(0.001)	(0.001)	(0.007)	(0.055)
Gr. 6 Math Score	--	0.020***	0.189***	-1.188***
	--	(0.004)	(0.023)	(0.209)
School Count * Test Score	--	--	-0.016***	0.117***
	--	--	(0.002)	(0.020)
<u>Gr. 6 Individual Characteristics</u>				
Female	0.019***	0.019***	0.019***	0.019***
	(0.006)	(0.006)	(0.006)	(0.008)
ESL Student	0.028**	0.024*	0.027*	0.005
	(0.012)	(0.014)	(0.014)	(0.020)
Gifted Student	0.117***	0.097***	0.097***	0.098***
	(0.020)	(0.022)	(0.022)	(0.036)
Special Ed. Student	0.020	0.024*	0.030**	-0.016
	(0.013)	(0.014)	(0.014)	(0.025)
French Immersion Student	0.461***	0.459***	0.452***	0.511***
	(0.013)	(0.013)	(0.013)	(0.023)
<u>Neighbourhood Characteristics (FSA)</u>				
Average Household Income ($1000)	-0.002***	-0.002***	-0.002***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.001)
% of population without HS diploma	0.000	-0.000	-0.002	0.012***
	(0.002)	(0.002)	(0.002)	(0.003)
% of population with Bachelor's or higher	-0.001	-0.002	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
% of population immigrant	0.016***	0.016***	0.016***	0.018***
	(0.001)	(0.001)	(0.001)	(0.002)
% of population with English as first	0.013***	0.013***	0.012***	0.022***

language	(0.001)	(0.001)	(0.001)	(0.002)
% of population southwest Asian origin	0.000	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.001)
% of population east Asian origin	0.000	0.000	0.000	0.003***
	(0.000)	(0.000)	(0.000)	(0.001)
Population density (1000/ km^2)	0.008***	0.009***	0.012***	-0.005
	(0.002)	(0.002)	(0.002)	(0.005)
Board Dummies				
Dufferin-Peel Catholic DSB	-0.047***	-0.047***	-0.044***	-0.072***
	(0.015)	(0.015)	(0.015)	(0.019)
Peel DSB	0.159***	0.157***	0.146***	0.239***
	(0.012)	(0.012)	(0.012)	(0.023)
Durham Catholic DSB	-0.072***	-0.073***	-0.058***	-0.182***
	(0.020)	(0.020)	(0.021)	(0.041)
Durham DSB	0.017	0.013	0.031	-0.113***
	(0.019)	(0.019)	(0.020)	(0.035)
Toronto Catholic DSB	0.220***	0.221***	0.219***	0.237***
	(0.008)	(0.008)	(0.008)	(0.013)
Toronto DSB	Omitted	--	--	--
	--	--	--	--
York DSB	0.090***	0.090***	0.062***	0.289***
	(0.013)	(0.013)	(0.012)	(0.046)
York Catholic DSB	0.043***	0.041***	0.024	0.160***
	(0.015)	(0.016)	(0.015)	(0.038)
Constant	-1.380***	-1.409***	-1.771***	1.183**
	(0.173)	(0.175)	(0.178)	(0.574)
Observations	28,527	27,781	27,781	27,781
R-squared	0.117	0.118	0.095	--

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3-9 – IV First Stage Regressions, Reading

First Stage Regression: Linear Probability Regressions Using Distance to Board Boundary as Instrument – Reading Scores			
	(1)	(2)	(3)
VARIABLES	Dep. Var - Accessible High School Count	Dep. Var Accessible High School Count	Dep. Var - Accessible High School Count * Ability
Accessible High School Count	--	--	2.645***
	--	--	(0.008)
Gr. 6 Reading Score	-0.095***	-3.085***	10.348***
	(0.027)	(0.016)	(0.037)
School Count * Test Score	--	0.296***	--
	--	(0.001)	--
Gr. 6 Individual Characteristics			
Female	0.056	0.027	-0.051
	(0.037)	(0.017)	(0.052)
ESL Student	-0.071	-0.035	0.065
	(0.088)	(0.041)	(0.122)
Gifted Student	0.875***	0.222***	-0.108
	(0.139)	(0.065)	(0.193)
Special Ed. Student	-0.180**	-0.110***	0.240*
	(0.089)	(0.042)	(0.124)
French Immersion Student	-0.207**	0.049	-0.315**
	(0.096)	(0.045)	(0.134)
Neighbourhood Characteristics (FSA)			
Average Household Income ($1000)	-0.023***	-0.008***	0.010***
	(0.002)	(0.001)	(0.003)
% of population without HS diploma	0.506***	0.113***	-0.011
	(0.012)	(0.006)	(0.017)
% of population with Bachelor's or higher	0.448***	0.076***	0.072***
	(0.009)	(0.004)	(0.013)
% of population immigrant	-0.055***	0.000	-0.041***
	(0.008)	(0.004)	(0.011)
% of population with English as first language	-0.060***	0.008**	-0.070***

	(0.008)	(0.004)	(0.011)
% of population southwest Asian origin	-0.027***	-0.009***	0.012***
	(0.003)	(0.001)	(0.004)
% of population east Asian origin	0.018***	0.009***	-0.018***
	(0.003)	(0.001)	(0.004)
Population density (1000/ km^2)	0.338***	0.066***	0.025
	(0.015)	(0.007)	(0.021)
<u>Board Dummies</u>			
Dufferin-Peel Catholic DSB	-3.169***	-0.576***	-0.373***
	(0.093)	(0.044)	(0.133)
Peel DSB	-4.379***	-0.795***	-0.520***
	(0.073)	(0.036)	(0.108)
Durham Catholic DSB	-4.362***	-0.743***	-0.680***
	(0.158)	(0.075)	(0.223)
Durham DSB	-4.787***	-0.923***	-0.384**
	(0.127)	(0.060)	(0.181)
Toronto Catholic DSB	0.272***	0.047*	0.039
	(0.054)	(0.025)	(0.075)
Toronto DSB	Omitted	--	--
	--	--	--
York DSB	-5.154***	-0.620***	-1.678***
	(0.069)	(0.035)	(0.105)
York Catholic DSB	-6.271***	-0.785***	-1.937***
	(0.091)	(0.046)	(0.136)
Constant	-6.943***	5.318***	-23.032***
	(-1.117)	(-0.521)	(-1.554)
Distance to Board Boundary	1.978***	0.386***	0.144***
	(0.015)	(0.009)	(0.027)
Observations	27,721	27,721	27,721
Adjusted R-squared	0.722	0.940	0.943

Table 3-10 – IV Second Stage Regressions, Reading

Second Stage Regression: Linear Probability Regressions Using Distance to Board Boundary as Instrument – Reading Scores			
	(1)	(2)	(3)
VARIABLES	Instrument for School Choice – add ability	Instrument for School Choice – add choice*ability	Instrument for Choice * Ability
Accessible High School Count	0.013***	0.060***	-0.417***
	(0.001)	(0.007)	(0.086)
Gr. 6 Reading Score	0.023***	0.203***	-1.614***
	(0.004)	(0.024)	(0.332)
School Count * Test Score	--	-0.0175***	0.158***
	--	(0.002)	(0.032)
<u>Gr. 6 Individual Characteristics</u>			
Female	0.015***	0.014**	0.024**
	(0.006)	(0.006)	(0.010)
ESL Student	0.030**	0.031**	0.019
	(0.014)	(0.014)	(0.026)
Gifted Student	0.095***	0.092***	0.122***
	(0.022)	(0.022)	(0.044)
Special Ed. Student	0.028**	0.033**	-0.012
	(0.014)	(0.014)	(0.031)
French Immersion Student	0.461***	0.455***	0.508***
	(0.013)	(0.013)	(0.027)
<u>Neighbourhood Characteristics (FSA)</u>			
Average Household Income ($1000)	-0.002***	-0.002***	-0.004***
	(0.000)	(0.000)	(0.001)
% of population without HS diploma	0.000	-0.001	0.008**
	(0.002)	(0.002)	(0.003)
% of population with Bachelor’s or higher	-0.001	-0.001	-0.008**
	(0.001)	(0.001)	(0.003)
% of population immigrant	0.016***	0.016***	0.022***
	(0.001)	(0.001)	(0.002)
% of population with English as first language	0.013***	0.012***	0.024***
	(0.001)	(0.001)	(0.003)

% of population southwest Asian origin	0.000	0.000	-0.002**
	(0.000)	(0.000)	(0.001)
% of population east Asian origin	0.000	-0.000	0.003***
	(0.000)	(0.000)	(0.001)
Population density (1000/ km^2)	0.010***	0.010***	0.010*
	(0.002)	(0.002)	(0.005)
<u>Board Dummies</u>			
Dufferin-Peel Catholic DSB	-0.049***	-0.051***	-0.026
	(0.015)	(0.015)	(0.022)
Peel DSB	0.157***	0.154***	0.189***
	(0.012)	(0.012)	(0.021)
Durham Catholic DSB	-0.071***	-0.078***	-0.014
	(0.020)	(0.020)	(0.050)
Durham DSB	0.015	0.014	0.021
	(0.019)	(0.020)	(0.037)
Toronto Catholic DSB	0.222***	0.222***	0.219***
	(0.008)	(0.008)	(0.015)
Toronto DSB	Omitted	--	--
	--	--	--
York DSB	0.089***	0.067***	0.295***
	(0.013)	(0.012)	(0.055)
York Catholic DSB	0.038**	0.012	0.272***
	(0.016)	(0.015)	(0.064)
Constant	-1.444***	-1.837***	2.116**
	(0.175)	(0.179)	(0.861)
Observations	27,721	27,721	27,721
R-squared	0.119	0.096	

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3-11 – Comparison of School Entering Cohorts by Extent of "Switchers", Math

Comparison of Entering Cohorts to High Schools by Extent of "Local" Students Versus "Switchers," Using Different Tercile Cutoffs for each Board (Math Scores)

	Cutoff (%) for low tercile	Cutoff (%) for medium tercile	Average Gr 6 Math score: Low Switchers	Average Gr 6 Math score: Medium Switchers	Average Gr 6 Math score: High Switchers	High Switching Schools only: Local Students	High Switching Schools only: Switchers	Number of Students (N - math)
Dufferin Peel Catholic DSB	31.8	38.6	**2.73**	2.59	**2.65**	2.64	2.66	12,530
Peel DSB	26.5	38.7	**2.72**	2.62	**2.93**	**2.74**	**3.03**	15,485
Durham Catholic DSB	19.8	27.9	**2.72**	2.60	**2.68**	2.65	2.72	3,660
Durham DSB	17.9	26.3	**2.68**	2.64	**2.79**	2.77	2.82	8,348
Toronto Catholic DSB - nearest school	64.0	83.4	2.60	2.59	**2.75**	**2.86**	**2.73**	11,022
Toronto DSB - include tech/comm	28.2	43.8	**2.67**	2.81	**2.85**	**2.74**	**2.91**	26,026
York Catholic DSB	20.3	30.8	**2.80**	2.89	**3.05**	3.03	3.07	7,169
York Region DSB	26.8	35.9	**2.89**	2.94	**3.03**	3.03	3.02	13,221

Notes: Each high school was ranked in order of the percentage of its grade 9 enrolment who were defined as "switchers" (i.e. those who opted out of their assigned high school). Based on this metric, the schools were then separated into terciles for each Board (each Board has a separate cutoff point for the terciles). Bold in the columns for terciles 1 and 3 indicates that the mean is statistically different from the mean of the 2nd tercile at the 95% CI. Bold in the columns for local students indicates that the mean is significantly different from the mean of the switchers (and vice-versa). Test scores are based on a scale from 0 to 4, where 3 and above are considered to have met the provincial standard. The standard deviation of the test score is 0.75 for math and 0.7 for reading.

Table 3-12 Comparison of School Entering Cohorts by Extent of "Switchers", Reading

Comparison of Entering Cohorts to High Schools by Extent of "Local" Students Versus "Switchers," Using Different Tercile Cutoffs for each Board (Reading Scores)

			Average Gr 6 Reading score					
	Cutoff (%) for low tercile	Cutoff (%) for medium tercile	Low Switchers	Medium Switchers	High Switchers	High Switching Schools only: Local Students	High Switching Schools only: Switchers	Number of Students (N - reading)
Dufferin Peel Catholic DSB	31.8	38.6	**2.78**	2.67	2.70	2.68	2.71	12,536
Peel DSB	26.5	38.7	**2.69**	2.61	**2.90**	**2.72**	**2.99**	15,466
Durham Catholic DSB	19.8	27.9	**2.76**	2.65	**2.71**	**2.69**	**2.74**	3,660
Durham DSB	17.9	26.3	**2.72**	2.66	**2.80**	2.79	2.81	8,347
Toronto Catholic DSB - nearest school	64.0	83.4	2.58	2.61	**2.72**	**2.81**	**2.71**	11,048
Toronto DSB - include tech/comm	28.2	43.8	**2.61**	2.74	**2.80**	**2.70**	**2.87**	25,968
York Catholic DSB	20.3	30.8	2.83	2.85	**2.97**	2.97	2.97	7,171
York Region DSB	26.8	35.9	**2.79**	2.85	**2.91**	2.91	2.91	13,185

Notes: Each high school was ranked in order of the percentage of its grade 9 enrolment who were defined as "switchers" (i.e. those who opted out of their assigned high school). Based on this metric, the schools were then separated into terciles for each Board (each Board has a separate cutoff point for the terciles). Bold in the columns for terciles 1 and 3 indicates that the mean is statistically different from the mean of the 2nd tercile at the 95% CI. Bold in the columns for local students indicates that the mean is significantly different from the mean of the switchers (and vice-versa). Test scores are based on a scale from 0 to 4, where 3 and above are considered to have met the provincial standard. The standard deviation of the test score is 0.75 for math and 0.7 for reading.

Figures

Figure 3-1 – An Example of a School Travel Zone

Thistletown CI (Toronto-Peel-York Boundary)

Notes: A star represents a high school. The star from which the ten lines are emanating represents Thistletown Collegiate Institute in Toronto District School Board (other stars represent other local high schools). Dots represent the postal codes of students attending Thistletown CI. Each pie-shaped wedge contains ten-percent of the student population of the high school. The heavy black lines indicate the 75th percentile distance from the school of the students living within that wedge. Therefore, by construction, 75 percent of Thistletown CI's student population resides within its empirical travel zone.

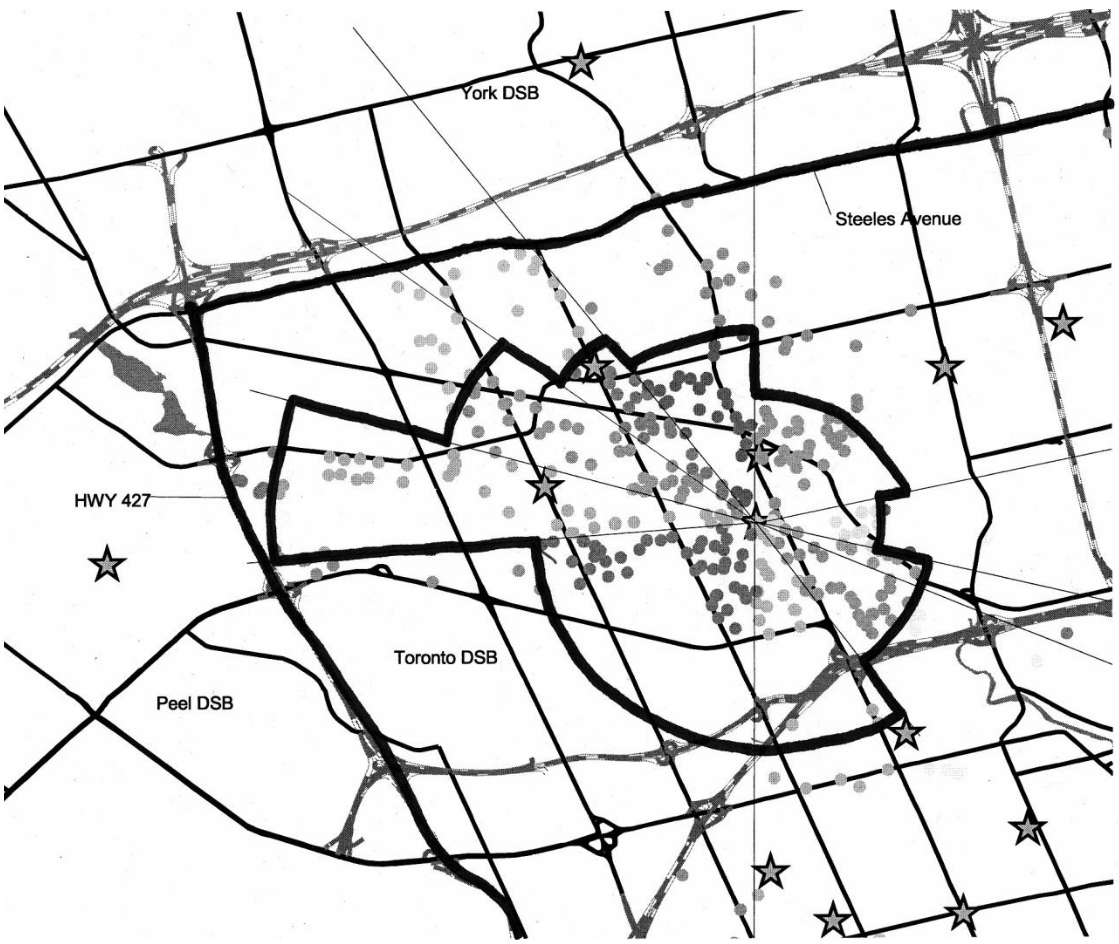
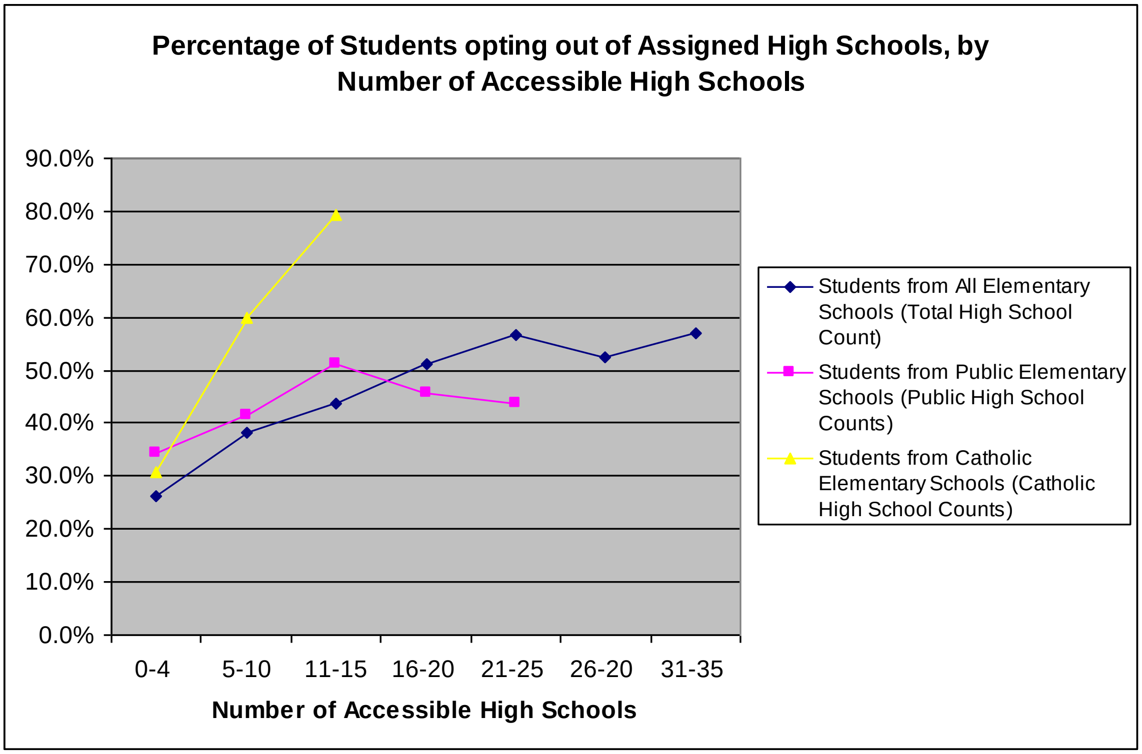
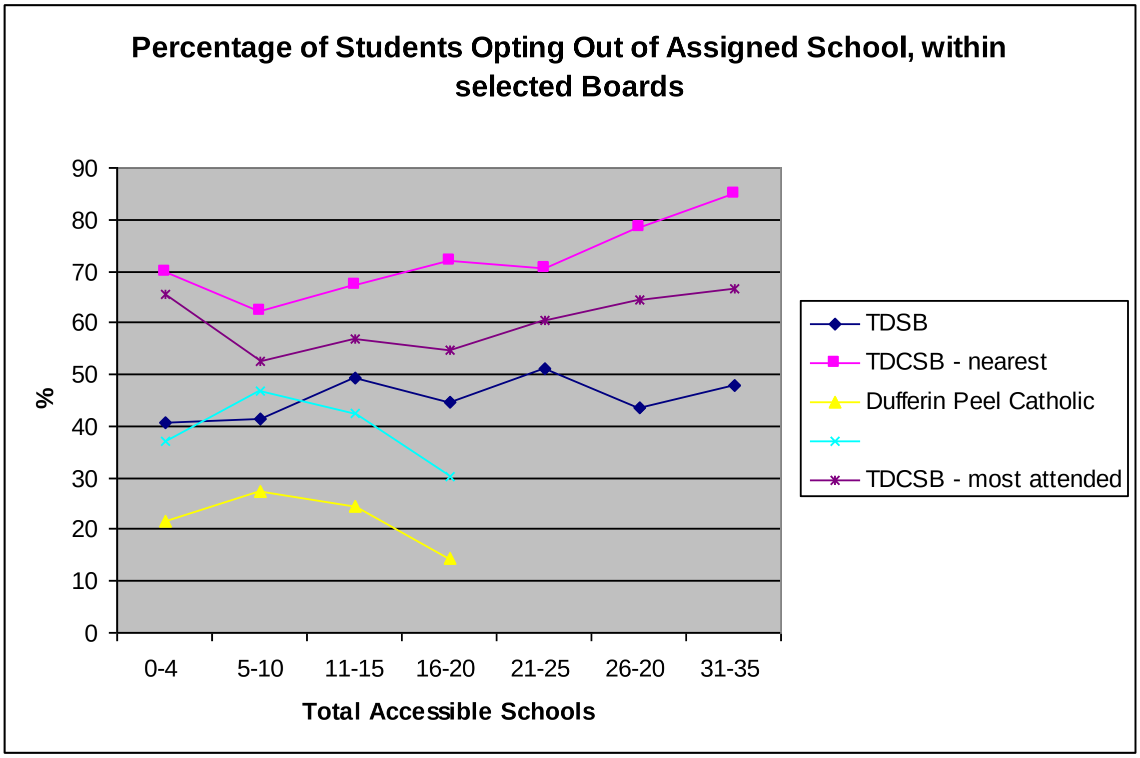


Figure 3-2 – Percentage of Students Opting Out, by Number of Accessible Schools



Notes: Uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB.

Figure 3-3 – Opt Outs by Number of Accessible Schools and School Board



Appendix 1 - Comparison of Test Score Methodology (Linear versus Dummy Variables)

Appendix Table 3-13 – Comparison of linear test score versus score dummies

Summary comparison of linear test scores vs. individual dummies						
	Math Scores			Reading Scores		
Linear test score	0.018***	--	--	0.020***	--	--
	(0.004)	--	--	(0.004)	--	--
Score of 2 or less dummy	--	-0.010**	--	--	-0.018***	--
	--	(0.005)	--	--	(0.005)	--
Score of 4 dummy	--	0.042***	--	--	0.050***	--
	--	(0.006)	--	--	(0.007)	--
Score of 0 dummy	--	--	0.073	--	--	0.047**
	--	--	(0.050)	--	--	(0.023)
Score of 1 dummy	--	--	-0.009	--	--	-0.012
	--	--	(0.010)	--	--	(0.009)
Score of 2 dummy	--	--	-0.011**	--	--	-0.020***
	--	--	(0.005)	--	--	(0.005)
Score of 4 dummy	--	--	0.042***	--	--	0.049***
	--	--	(0.006)	--	--	(0.007)

Notes: Columns 1 and 4 report the same regressions as presented in Table 4.
*** p<0.01, ** p<0.05, * p<0.1

Appendix 2 - Within Board Regressions with School Choice Counts

Appendix Table 3-14 – Within Board Regressions Including Choice Variables, Math

Summary Results of Linear Probability Regressions for Likelihood of Opting Out of Assigned School, within School Boards, Using math scores as Ability and Adding School Choice Variables

	Number of Accessible Schools	Gr. 6 Math Score	Number of Accessible Schools	Gr. 6 Math Score	School choice* ability
Dufferin_Peel Catholic DSB	0.003	0.022**	-0.002	0.005	0.002
	(0.005)	(0.009)	(0.007)	(0.021)	(0.002)
Peel DSB	-0.006	0.026***	0.001	0.047**	-0.003
	(0.006)	(0.008)	(0.007)	(0.022)	(0.002)
Durham Catholic DSB	0.025	-0.011	0.011	-0.030	0.005
	(0.014)	(0.011)	(0.019)	(0.026)	(0.007)
Durham DSB	0.005	-0.040***	0.058***	0.041	-0.020***
	(0.012)	(0.010)	(0.018)	(0.029)	(0.007)
Toronto Catholic DSB	0.002	0.003	0.001	-0.007	0.001
	(0.003)	(0.011)	(0.004)	(0.025)	(0.001)
Toronto DSB	0.002	0.042***	0.001	0.034**	0.000
	(0.002)	(0.007)	(0.003)	(0.015)	(0.001)
York Catholic DSB	0.017	0.018**	-0.004	-0.013	0.007
	(0.012)	(0.008)	(0.018)	(0.026)	(0.006)
York DSB	0.011	-0.010	-0.011	-0.046	0.007
	(0.009)	(0.008)	(0.023)	(0.039)	(0.008)

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3-15 - Within Board Regressions Including Choice Variables, Reading

Summary Results of Linear Probability Regressions for Likelihood of Opting Out of Assigned School, within School Boards, Using reading scores as Ability and Adding School Choice Variables

	Number of Accessible Schools	Gr. 6 Reading Score	Number of Accessible Schools	Gr. 6 Reading Score	School choice* ability
Dufferin-Peel Catholic DSB	0.003	0.031***	0.000	0.0256**	0.001
	(0.005)	(0.010)	(0.005)	(0.010)	(0.001)
Peel DSB	-0.006	0.033***	-0.007	0.032***	0.001
	(0.006)	(0.009)	(0.006)	(0.009)	(0.001)
Durham Catholic DSB	0.026*	-0.019*	0.025	-0.019*	0.000
	(0.014)	(0.011)	(0.015)	(0.010)	(0.003)
Durham DSB	0.005	-0.042***	0.029**	-0.020*	-0.009***
	(0.012)	(0.011)	(0.011)	(0.011)	(0.002)
Toronto Catholic DSB	0.002	0.014	0.003	0.015	0.000
	(0.003)	(0.010)	(0.003)	(0.010)	(0.000)
Toronto DSB	0.002	0.037***	-0.002	0.022***	0.001***
	(0.002)	(0.006)	(0.002)	(0.006)	(0.000)
York Catholic DSB	0.017	0.005	0.001	-0.008	0.005***
	(0.012)	(0.009)	(0.014)	(0.010)	(0.002)
York DSB	0.011	0.002	0.015	0.005	-0.001
	(0.009)	(0.008)	(0.010)	(0.008)	(0.002)

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 3 - Details for IV Strategy

Appendix Table 3-16 – Correlations for IV Strategy

Correlations between total count of accessible high schools and distance from Toronto DSB boundary

	N	Correlation
Full sample (Toronto, Peel York, and Durham)	99858	-0.127
Restrict to distance<30 km	98198	-0.072
Restrict to distance<25 km	94382	0.035
Restrict to distance <5 km	28684	0.423
Restrict to Toronto Boards	41138	0.638
TDSB and TCDSB and distance<5 km	16792	0.671
Restrict to Peel, York, and Durham (Public and Catholic)	58720	-0.203
Peel, York, and Durham and <5 km	11892	0.124

Notes: Distance variable is measured for schools in areas of Toronto DSB, York DSB, Durham DSB, and Peel DSB. For schools in Toronto DSB, distance variable is the distance from the elementary school to the nearest postal code in the Peel, York or Durham Boards. If the elementary school is in Peel, York, or Durham Board, the distance is measured as the distance to the nearest postal code in the Toronto DSB.

Appendix 4 - Robustness to changes in OV 5 km restriction

Appendix Table 3-17 – Sensitivity Tests for IV Regressions to 5 km Boundary Restriction, Math

Sensitivity Test for IV Regressions Altering the 5 km Restriction - Math Scores							
		Table 3-8 - Column 1	Table 3-8 - Column 2		Table 3-8 - Column 3		
	N	Accessible school count	Accessible school count	Math score	Accessible school count	Math score	Choice * Score
4 km	22,302	0.00328**	0.00265*	0.0219***	0.00766	0.0388	-0.00176
		(0.0016)	(0.0016)	(0.0044)	(0.0090)	(0.0265)	(0.0027)
5 km	27,781	0.0127***	0.0127***	0.0199***	0.0581***	0.189***	-0.0163***
		(0.0011)	(0.0011)	(0.0040)	(0.0070)	(0.0233)	(0.0022)
6 km	34,129	0.0128***	0.0130***	0.0204***	0.0580***	0.194***	-0.0165***
		(0.0012)	(0.0012)	(0.0036)	(0.0067)	(0.0225)	(0.0021)
7 km	39,486	0.00924***	0.00943***	0.0214***	0.0388***	0.135***	-0.0107***
		(0.0011)	(0.0011)	(0.0033)	(0.0063)	(0.0211)	(0.0020)
8 km	45,972	0.00619***	0.00641***	0.0169***	0.0200***	0.0747***	-0.00506***
		(0.0009)	(0.0009)	(0.0031)	(0.0043)	(0.0155)	(0.0013)
9 km	50,132	0.00418***	0.00436***	0.0159***	0.0107***	0.0431***	-0.00233*
		(0.0008)	(0.0008)	(0.0029)	(0.0040)	(0.0148)	(0.0012)
10 km	57,505	0.000867	0.001	0.0168***	-0.00421	-0.00594	0.00192
		(0.0008)	(0.0008)	(0.0028)	(0.0040)	(0.0146)	(0.0012)
11 km	63,688	0.000498	0.000731	0.0178***	-0.00467	-0.00658	0.00200*
		(0.0008)	(0.0008)	(0.0026)	(0.0035)	(0.0132)	(0.0011)

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3-18 – Sensitivity Tests for IV Regressions to 5 km Boundary Restriction, Reading

Sensitivity Test for IV Regressions Altering the 5 km Restriction - Reading Scores						
		Table 3-10 - Column 1		Table 3-10 - Column 2		
	N	Accessible school count	Reading score	Accessible school count	Reading score	Choice * Score
4 km	22,255	0.00269*	0.0233***	0.00942	0.0468*	-0.00245
		(0.0016)	(0.0047)	(0.0090)	(0.0274)	(0.0028)
5 km	27,721	0.0126***	0.0225***	0.0600***	0.203***	-0.0175***
		(0.0011)	(0.0042)	(0.0071)	(0.0243)	(0.0023)
6 km	34,068	0.0130***	0.0231***	0.0645***	0.225***	-0.0191***
		(0.0012)	(0.0038)	(0.0072)	(0.0250)	(0.0023)
7 km	39,417	0.00947***	0.0221***	0.0453***	0.163***	-0.0132***
		(0.0011)	(0.0035)	(0.0069)	(0.0240)	(0.0022)
8 km	45,885	0.00652***	0.0178***	0.0226***	0.0870***	-0.00598***
		(0.0009)	(0.0032)	(0.0047)	(0.0174)	(0.0015)
9 km	50,041	0.00443***	0.0156***	0.0121***	0.0492***	-0.00285**
		(0.0008)	(0.0031)	(0.0044)	(0.0164)	(0.0014)
10 km	57,419	0.00104	0.0184***	-0.00368	-0.00244	0.00174
		(0.0008)	(0.0029)	(0.0043)	(0.0160)	(0.0013)
11 km	63,611	0.000767	0.0204***	-0.00448	-0.00366	0.00196*
		(0.0008)	(0.0028)	(0.0038)	(0.0144)	(0.0012)

Notes: The opt-out variable uses my preferred definition of "assigned" school, which includes TDSB tech/commercial schools and uses the nearest high school for TCDSB. Robust standard errors (clustered on Gr 6 school) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix 5 - Defining "Opting Out" in Toronto Catholic District School Board

Appendix Table 3-19 – Table 3-4 Alternative TCDSB Definitions

This Appendix examines the robustness of my results to changes in the definition of "assigned high school" in the Toronto Catholic District School Board. As described in the text, the TCDSB does not have assigned high schools. Rather, all TCDSB students are eligible for all TCDSB high schools.

The first columns of Appendix Tables 3-19 to 3-22 present the main results from Tables 3-4, 3-6, 3-8, and 3-10, respectively, using the nearest TCDSB high school as the assigned school for children enrolled in TCDSB elementary schools (as originally reported in the main body of the paper). The second column presents an alternative definition of the assigned high school: the high school that is most attended by members of the student's elementary school. The final column presents the results once having dropped all students who attended elementary school in the TCDSB.

Summary of Table 3-4 Regressions Under Alternative Definitions of "Assigned High School" for TCDSB

Table 3-4 Column Number	Regression	Variable	Basic - Nearest school (as reported in Table 3-4)	Alternative TCDSB definition - Most Attended School	Drop TCDSB entirely
1	Basic	Grade 6 Math Score	0.018*** (0.004)	0.017*** (0.004)	0.020*** (0.004)
2	Fixed Effects	Grade 6 Math Score	0.025*** (0.003)	0.023*** (0.003)	0.026*** (0.003)
3	Basic	Grade 6 Reading Score	0.020*** (0.004)	0.019*** (0.004)	0.021*** (0.004)
4	Fixed Effects	Grade 6 Reading Score	0.026*** (0.003)	0.025*** (0.003)	0.027*** (0.003)

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3-20 – Table 3-6 Alternative TCDSB Definitions

Summary of Table 3-6 Regressions Under Alternative Definitions of "Assigned High School" for TCDSB

Table 3-6 Column Number	Regression	Variable	Basic - Nearest school (as reported in Table 3-6)	Alternative TCDSB definition - Most Attended School	Drop TCDSB entirely
1	Basic	Accessible High School Count	0.001	0.001	0.001
			(0.001)	(0.001)	(0.002)
		Grade 6 Math Score	0.018***	0.017***	0.021***
			(0.004)	(0.004)	(0.004)
2	Add interaction	Accessible High School Count	-0.002	-0.002	-0.003
			(0.002)	(0.002)	(0.002)
		Grade 6 Math Score	0.005	0.005	0.003
			(0.006)	(0.006)	(0.006)
		School Count * Test Score	0.001**	0.001**	0.002***
			(0.000)	(0.000)	(0.001)
3	Basic	Accessible High School Count	0.001	0.001	0.001
			(0.001)	(0.001)	(0.002)
		Grade 6 Reading Score	0.020***	0.019***	0.022***
			(0.003)	(0.004)	(0.004)
4	Add interaction	Accessible High School Count	-0.002	-0.002	-0.003
			(0.002)	(0.002)	(0.002)
		Grade 6 Reading Score	0.005	0.007	0.005
			(0.006)	(0.006)	(0.006)
		School Count * Test Score	0.001***	0.001**	0.001***
			(0.000)	(0.000)	(0.000)

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3-21 – Table 3-8 Alternative TCDSB Definitions

Summary of Table 3-8 Regressions Under Alternative Definitions of "Assigned High School" for TCDSB

Table 3-8 Column Number	Regression	Variable	Basic - Nearest school (as reported in Table 3-8)	Alternative TCDSB definition - Most Attended School	Drop TCDSB entirely
1	School choice only	Accessible High School Count	0.013***	0.010***	0.011***
			(0.001)	(0.001)	(0.001)
2	Add Ability	Accessible High School Count	0.013***	0.010***	0.012***
			(0.001)	(0.001)	(0.001)
		Grade 6 Reading Score	0.020***	0.016***	0.027***
			(0.004)	(0.004)	(0.004)
3	Add choice* ability	Accessible High School Count	0.058***	0.047***	0.035***
			(0.007)	(0.007)	(0.009)
		Grade 6 Reading Score	0.189***	0.157***	0.109***
			(0.023)	(0.023)	(0.027)
		School Count * Test Score	-0.016***	-0.014***	-0.008***
			(0.002)	(0.002)	(0.003)
4	Instrument for Choice* Ability	Accessible High School Count	-0.312***	-0.267***	-0.157***
			(0.055)	(0.051)	(0.042)
		Grade 6 Reading Score	-1.190***	-1.010***	-0.560***
			(0.209)	(0.194)	(0.152)
		School Count * Test Score	0.117***	0.099***	0.060***
			(0.020)	(0.019)	(0.016)

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3-22 – Table 3-10 Alternative TCDSB Definitions

Summary of Table 3-10 Regressions Under Alternative Definitions of "Assigned High School" for TCDSB

Table 7 Column Number	Regression	Variable	Basic - Nearest school (as reported in Table 3-10)	Alternative TCDSB definition - Most Attended School	Drop TCDSB entirely
1	Add Ability (Reading)	Accessible High School Count	0.013***	0.009***	0.011***
			(0.001)	(0.001)	(0.001)
		Grade 6 Reading Score	0.023***	0.019***	0.027***
			(0.004)	(0.004)	(0.005)
2	Add Choice*Ability	Accessible High School Count	0.060***	0.051***	0.039***
			(0.007)	(0.007)	(0.009)
		Grade 6 Reading Score	0.203***	0.175***	0.125***
			(0.024)	(0.024)	(0.029)
		School Count * Test Score	-0.018***	-0.015***	-0.010***
			(0.002)	(0.002)	(0.003)
3	Instrument for Choice*Ability	Accessible High School Count	0.158***	0.134***	0.067***
			(0.032)	(0.029)	(0.018)
		Grade 6 Reading Score	-0.417***	-0.354***	-0.171***
			(0.086)	(0.078)	(0.049)
		School Count * Test Score	-1.614***	-1.370	-0.620***
			(0.332)	(0.302)	(0.178)

Notes: *** p<0.01, ** p<0.05, * p<0.1.

4) Full-day versus Half-day Kindergarten: Long Run Effects on Test Scores

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4.1 Introduction and Literature Review

There has been much recent policy interest in investing in early childhood education, following on research that suggests it can provide a potentially high return method of raising individual earnings and the overall human capital stock, while also reducing crime rates, welfare dependency, and other negative social outcomes.

Much of this research is based on evaluations of programs that were tightly targeted to disadvantaged students. The heavily studied Perry Pre-School program, targeted at disadvantaged, low-IQ 4-5 year olds, has been found to have led to only short-term improvements in test scores, but to long-term improvements in earnings and criminal activity (Carneiro & Heckman, 2004). The Carolina Abecedarian program, an experiment that provided very intensive interventions to infants in low-income families over a number of years, has been found to be associated with both higher cognitive test scores and improved economic and social outcomes during young adulthood (Campbell et al., 2010). The evidence on Head Start is more mixed, but recent research suggests it too has led to higher college attendance and a lower propensity to engage in criminal activity (Garces, Thomas & Currie, 2002). More recently, Chetty et al. (2011), using evidence from Project STAR (an experiment undertaken in comparatively low-income schools in Tennessee in the mid 1980s), find that reduced class sizes in kindergarten leads to higher wages, college attendance rates, home ownership and retirement saving at age 27.

The typical findings of these studies are that they provide an initial boost to cognitive test scores of various sorts which fades out after some years, but that there appear to be more beneficial long-term outcomes on dimensions including college attendance, employment, and propensity to engage in criminal activity. Drawing on these results, Heckman and colleagues have argued that early childhood education can generate higher returns than education investments later in life, because young children can learn more efficiently than adults, and because investments in early childhood are complementary to later education – that "learning begets learning" (see, eg, Heckman (1998), Carneiro & Heckman (2004), Heckman (2006), Doyle et al. (2009)). In Canada, a similar argument has long been made by McCain & Mustard, who state that “evidence from neurobiology, animal studies, epidemiological and longitudinal studies of populations, intervention studies, and observational studies reaffirms that experience-based brain development in the early years of life, including the in utero period, affects learning, behaviour, and physical and mental health throughout life” (McCain & Mustard, 1999, 2002). There is some dispute, however, about the degree to which the notion of critical periods in development that is implicit in this argument is supported by empirical evidence (Almond, Duncun &Currie, 2010).

As noted, the programs that have been credibly identified as being the most effective in improving longer-run outcomes have been heavily targeted at disadvantaged children, but many of the recent policy innovations that have been motivated by those findings are universal in nature. Krueger (2004) argues that though there is evidence of strong returns to investing in enrichment programs targeted to disadvantaged children, there is little evidence that investments in universal early childhood education have higher returns than does investment in older people. Currie (2001) and Baker (2011a) also note the lack of evidence on universal public programs. Further, the ultimate effects of changes in early childhood education depend on later decisions made by individuals, families, teachers and schools, which may change in response to changes in early learning (Carneiro & Heckman, 2004, Krueger, 2004). This underscores the importance of investigating the effects of actually-implemented policy changes, rather than relying only on evidence from quite different programs supported by neuro-biological evidence to form expectations of any given program's effects.

This is particularly true of the tendency to extend the time that young children spend in formal education programs, such as the move towards increasing access to publicly-funded full-day kindergarten. In the US, full-day kindergarten has become increasingly popular – the proportion of kindergarteners in full-day programs rose from around 13% in 1970 to 60% by 2000 (Cannon et al., 2006). In Canada, provincial governments in Ontario and British Columbia have recently begun a move from half-day to full-day kindergarten. Evaluation of the effects of universally-available full-day kindergarten is not straightforward. In most cases, parents have a choice between full-day and half-day kindergarten. Thus, there is always the possibility that a move to full-day kindergarten in parts of a particular school system will lead to non-random selection of participants in the full-day program.

Researchers have identified both potential advantages and disadvantages of extending the school day for younger children. Lee et al. (2006) note that full-day kindergarten can improve student learning by providing more instructional time, as well as by enabling teachers to use more varied and more individualised instruction methods. They also note some disadvantages, however, including greater risk of stress and fatigue among young students spending a longer day in school, which may lead to behavioural problems. These possible costs are similar to those found among younger children in daycare by Baker et al. (2008).

There are some studies of the effects of full-day as distinct from half-day kindergarten programs on test scores and on children's behaviour, though there are fewer in the economics than in the education literature (DeCicca, 2007). Recently, Zvoch et al. (2008) summarise the research as finding positive effects on student performance in the short run – typically immediately after the end of the kindergarten year – but point to concerns that the methodologies typically used may not yield good estimates of the actual treatment effects. Common concerns include non-random assignment to full-day or half-day classes (Lee et al., 2006, Da Costa & Bell, 2001), a limited geographic focus (Da Costa& Bell, 2001), or a focus on disadvantaged students rather than the general population (Gullo 2000, Zvoch et al. 2008).

As in the literature on interventions targeted to disadvantaged children, it is also common to find immediate positive effects of kindergarten in at least some groups, but to see the effect begin to fade out within one to two years of the end of kindergarten. Very few studies are able to examine longer run effects of full-day kindergarten - indeed, in the literature, `long-term' is typically considered to be one to two years following the end of kindergarten (Gullo, 2000, DeCicca, 2007) with the exception of Cascio (2009b) and Decicca & Smith (2011). Cascio (2009b) studies rates of school dropout and long-run incomes among children who grew up in states which had kindergarten programs compared with those who did not. She finds little evidence of any of the long-run social benefits that early childhood advocates claim. On the other hand, she studied long run outcomes among children exposed to quite disparate school systems (since she relied on state-level variation in kindergarten policies), making it more difficult to separately identify the effects of kindergarten policies from other factors that could have contributed to long-run outcomes. Decicca & Smith (2011) take advantage of a policy break in the Canadian province of British Columbia in the early 1990's and find that children that were admitted at younger ages to kindergarten were more likely to repeat a grade at both ages nine and fifteen. Decicca & Smith (2011) look at the effect of admitting a child earlier in life to kindergarten while our paper looks at extending the daily time spent in kindergarten keeping the child's age the same. These two policies might have different results.

This paper examines a move to extend full-time kindergarten to children attending French language schools in Canada’s largest province, Ontario, over the late

1990s and early 2000s. During the same period, the English language schools offered kindergarten on a part-time basis only. This is an ideal quasi-experiment to study the introduction of universal full-day kindergarten. Since the full-day program was enacted in a public school district, schools were required to accept students who meet the criteria for enrolment. Since it was introduced only in the French language system, which accepts only students who have at least one parent who is fluent in French, switching between schools that introduced full-day kindergarten and those that did not was plausibly quite limited (and we show evidence that supports that initial assessment). It is possible, of course, that the introduction of full-day kindergarten could have induced French-speakers to leave the French board, but we believe that the lure of "free childcare" of full-day kindergarten likely increased the desirability of attending a French Board.

To our knowledge, the only research to date that investigates the specific policy change we study is Herry et al. (2007), which examines outcomes at the end of kindergarten among students in a single French language school board in the Ottawa region before and after the introduction of the full-day program. They found that students who had been through the full-day program had better language skills, and that there was no significant difference in behavioural outcomes. As the authors noted, though, the use of a single cohort before and after makes it difficult to ensure that any differences in outcomes were the result of the move to full-day kindergarten rather than other factors specific to the cohorts themselves.

Compared with previous studies of the length of the school day for young children (such as Cannon et al., 2006, or DeCicca, 2007), this proposed research has two key contributions. First, our research methodology alleviates concerns over non-random selection into full-day kindergarten. Mobility between the full- and half- day programs in this case is limited by requirements on the part of French language schools that enrolled students have at least one parent with a working knowledge of French. We can also use enrolment data in combination with Census data to examine whether there is any evidence of an increase (or decrease) in enrolment rates at French relative to English language schools. Second, we can examine longer run effects than is typical in the literature. Most previous studies only examine effects for one or two years following the introduction of full-day kindergarten. Here we can investigate test score outcomes up to six years following the end of kindergarten - a much longer time horizon than has been studied to date. As well, because we have observations on test scores in Grade 3 and Grade 6, we can examine whether there is any evidence that rates of learning increase for those exposed to full-day kindergarten, or whether there is a fade-out of early gains (as in DeCicca, 2007).

4.2 Institutional Background

Ontario's school K-12 school system, like most others in North America, comprises a government-funded sector and a private sector. The private sector receives essentially no public funding. Most recent estimates put the percentage Ontario's K-12 students who attend private schools at under 10 per cent.[20]

Also in common with other North American jurisdictions, Ontario's public schools each have an associated catchment area. Students attend the school in whose catchment area they live. There is only limited ability to attend another public school.

Unusually, however, Ontario has four separately-managed government-funded school systems: an English public, an English separate (Catholic), a French public, and a French separate (Catholic) system. Within each system, there are a number of Boards, which are non-overlapping and collectively cover the entire province. There are 12 French language boards (4 public and 8 Catholic) and 60 English language boards. As a result, any home location falls into the catchment area of a school run by each of the four types of school board. Enrolment in Catholic schools is preferentially available to students who have been baptized Catholic. Enrolment in French language schools is largely restricted to children who have at least one parent who has an adequate working knowledge of French. Therefore, children who have at least one parent who knows French, and who are Catholic, can be enrolled in any of their four local schools. Children who do not have a parent who knows French, and who are not Catholic, will typically only be able to attend the local English public school. These enrolment requirements are sometimes relaxed. It is increasingly possible for non-Catholic students to enrol in a Catholic school, for instance. Anecdotally, it is rare for French

[20] url{http://www.edu.gov.on.ca/eng/educationFacts.html} for public enrolment and url{http://www.ofis.ca/} for private enrollment (checked on March 1, 2012).

schools to relax the language requirement. The idiosyncrasies of this system of schooling have been used to study how competition between public and Catholic schools affects students' test scores (Card, Dooley & Payne, 2010).

Children are required to enrol in the first grade of school in September of the calendar year in which they turn 6. For many decades, Ontario has had two optional years of pre-school education: junior kindergarten (JK) and senior kindergarten (SK). Junior kindergarten programs began being offered in 1944, and has been available to students in all government schools over the period we are studying. When the programs began, both SK and JK were half day (roughly 2.5 hours each week day). More recently, some English language schools moved to a full-day alternate days kindergarten program, mostly to save on busing costs.[21] Although it is optional, kindergarten is extremely popular in Ontario, with enrolment rates well above 85% for both JK and SK.[22]

Ontario's French language school boards introduced full-day kindergarten at various times between the late 1990s and early 2000s (see Table 4-1 for a list of all the French language school boards and the dates they moved to full-day kindergarten), although some boards did offer full-day SK earlier than that. The Conseil Scolaire de district Catholique Centre-Sud was the first to introduce full-day kindergarten at the JK

[21] We have no information on what percentage of English language schools offered full-day alternate day kindergarten during our sample period. However, it has become more popular in the past 5 years or so, which is outside our sample range.

[22] Figures based on a comparison of 2006 enrolment numbers with Census estimates of the number of children of the relevant age. These give enrolment rates of 82% for JK, 87% for SK, and just over 90% for Grade 1 and Grade 2. This is broadly consistent with estimates that slightly fewer than 10% of students attend private schools.

level, in 1998-99. The Conseil des Ecole Publique de l'Est de l'Ontario (CEPEO) was the last, starting with the 2002-03 academic year.

The move to full-day kindergarten was motivated in part by the goal of improving academic achievement - and in particular scores on standardised tests administered Ontario-wide near the end of Grade 3, Grade 6 and Grade 9 - among students who were studying in the French language while living in a mostly English environment. It was thought that providing a longer time period of immersion in the language of instruction would boost language skills and improve students' ability to learn in other subject areas as well (Herry et al., 2007).

More recently, full-day kindergarten is being extended to all schools across the province. This includes French language schools, which are receiving funding for the full day, and which will now be required to comply with new curriculum and staffing regulations. This more recent policy change is outside the scope of our study.

We focus here on the switch to full-day kindergarten in the French language schools around a decade ago, and examine whether there is any evidence that it led to improved performance on standardized test scores, relative to students in English language schools, of cohorts in French language schools who received one or two years of full-day kindergarten. As a concrete example, we can examine whether test scores for students in the CEPEO board increased for cohorts taking the test after the 2005-06 academic year (the treated SK cohort), and for cohorts taking the Grade 6 test after the 2008-09 academic year.

Characteristics of Ontario's French-speaking Population

Our identification strategy relies on examining changes in test performance of students from French language schools, and therefore, for the most part, from Francophone households, relative to those in other households over time. It is helpful, therefore, to know that the Francophone population of Ontario looks similar on many socio-economic dimensions to the Anglophone population, and that there does not appear to be much change in this over time.

Francophones (or those who report both English and French as their first language) were around 4.4 per cent of Ontario's population in 2006, down from 4.6 per cent in 2001. Most of the decline is due to an increasing proportion of Census respondents reporting a language other than English or French as their first language (known as Allophones), a result of a rapid inflow of immigrants. Francophones have roughly similar levels of education and income as Anglophones. In the 2006 Census, 30 per cent of 25 to 40 year old Francophones had at least a BA, compared with 28 per cent for Anglophones. Personal incomes averaged roughly $40,000 for both groups. Rates of low income are similar among Anglophones and Francophones, at just over 12 per cent in the 2006 Census. Francophone education levels and incomes have been increasing relative to the Anglophone population over the study period, but only quite slowly.

The key difference between the Anglophone and Francophone populations is region of residence. Francophones are 17.7 per cent of the population in Ottawa, and

17.4 per cent of the population of the Sudbury/Thunder Bay area. They are also more likely to live outside a city than are Anglophones, forming 7.5 per cent of the non-city population. Consequently, these areas have a larger number of French language schools than other parts of the province. In contrast, Francophones are less than 2 per cent of the population of Toronto, Hamilton, Kitchener, London and Brantford.

Francophones are also much more likely to be Catholic, which explains the larger number of French Catholic than French public schools. They are more likely to be born in Canada than Anglophones, but also more likely to have been born outside Ontario.

The Anglophone and Francophone populations are, however, quite different than the Allophone population (that is, the group whose mother tongue is neither French nor English), who are much more likely to be immigrants, have higher education levels (41 per cent have at least a BA), and have substantially lower income.

4.3 Data

Our main question is whether the introduction of full-day kindergarten increased academic achievement among the treated cohorts. Our key policy variable is years of full-day kindergarten to which a child was eligible (Years FDK). This variable is determined based on the school board in which the child was registered at the time he or she took the EQAO test (in either Grade 3 or Grade 6). For instance, a student attending a school in the Conseil scolaire de district du Centre-Sud-Ouest/Viamonde who sat the Grade 3 EQAO test in 2000-01 (test year 2000) would have been eligible to attend kindergarten in that board only on a half day basis. Students in the 2000-01

Grade 3 cohort at this district would then have had Years FDK = 0. A student in the same district writing the Grade 3 test in the 2001 test year would have been in SK at the time that full-day kindergarten was introduced, and would have Years FDK = 1. A student writing in the 2002 test year would have been in JK when full-day kindergarten was introduced, and have Years FDK = 2.

Table 4-2 shows, for each year for which we have grade 3 EQAO test results, the total number of students in French language schools by the number of years of full-day kindergarten to which they had been exposed (and therefore, the number of students with each value of Years FDK). In 1998, around 12% of French language students had been enrolled in full-day kindergarten for one year only, and would have had Years FDK equal to 1. The remainder would have had Years FDK equal to 0. By the 2007 test year, all French language students had received two years of full-day kindergarten. The table also shows that the total numbers of French students stayed fairly stable across the years, which suggests there was no large scale movement into French-language schools after the start of the full-day kindergarten program.

Mobility across school boards is relatively limited – using one year of EQAO data that allows a match between test takers in grades 3 and 6, Baker (2011b) found that 83-86% of students in the English language system attended a school in the same board in the two years. He found that the average test scores and the change in average test scores for those who had stayed in the same school board were similar to (though marginally higher than) those who had switched school boards. Mobility is likely even lower in French language boards, which cover much larger geographic areas than do the English language boards. Data from Grade 3 suggest that more than 80% of students had been in the same French language school board for at least 3 years.

Our measure of academic achievement is taken from an Ontario-wide standardised test -- the Education Quality Accountability Office (EQAO) tests -- that have been taken by all Ontario school children in Grades 3, 6 and 9 since 1996-97. The data was collated and cleaned by the Public Economics Data Analysis Laboratory at McMaster University.

The EQAO tests are run in June each year, and consist of a combination of multiple choice and constructed response questions. They are administered over five days, with a maximum of three hours in testing each day (although it is common for students to finish much more quickly than that). The test format is identical for students in French and English.

Children schooled in French sit their exams entirely in the French language, while those schooled in English sit an English language exam. Schools that run French immersion programs can choose either to have their French immersion students sit only the mathematics test in French, or they can choose to have their students write the French math test along with the English reading and writing tests. The EQAO reports that the French language tests are not simple translations of the English language tests, in part because of slightly different curricula for the French and English language systems. They are, however, designed in tandem and are intended to be of similar difficulty. Around 40% of the test has been reported to be roughly identical between the two languages. The EQAO pays considerable attention to attempting to ensure that changes in test scores across years represent real changes in performance, using methods based on item response theory to calibrate the questions on the exams, and a fixed common item parameter equating procedure to analyse results (Pang et al., 2010).

The tests are graded by Ontario teachers using a rubric, with each child's results reported on a four point scale. A grade of 3 is considered to meet the provincial standard, while a grade of 4 indicates achievement "exceeds the provincial standard." A grade of 1 indicates that the student's achievement "falls much below the provincial standard," and a grade of 2 indicates that achievement "approaches the provincial standard." In a few cases, a student received a score of 0, indicating that he/she did not complete enough of the test to warrant a score. Success denotes that the student met the provincial standard (levels 3 or 4), while failure denotes that the student did not meet the provincial standard (levels 0, 1 and 2).

Students can be exempted from testing if the principal believes that the test would not be representative of their learning even with accommodations provided. Public reporting of the results at the school and board level focuses on results in which exempted students are included in the overall school results, and are assigned a result of not achieving the provincial standards. The proportion of students exempted has fallen in recent years (Auditor General of Ontario, 2009).

Initially we analyze the data using a binary dependent variable equal to one if the result is at or above the provincial standard, and we use linear probability models to estimate the effects of full-day kindergarten on the probability of success. Therefore our dependent variable S_{ibt} is a binary variable taking the value 1 if student i in board b at time t achieved a level of 3 or above on his/her standardised test. Note that this strategy is in line with public reporting which focuses on the simple percentage of students who met the provincial standard.

Unfortunately, collapsing different achievement levels together leads to a loss of some interesting information – in particular, we would not be able to tell if full-day kindergarten reduces the proportion of students scoring a grade of 1 and increases the proportion of students scoring a grade of 2, while leaving the proportion achieving a 3 or 4 unchanged. As a result, we also examine the results an alternative indicator variable: one indicating a grade of 2 or more on the provincial test. Examining the effects of full-day kindergarten at these levels may allow us to identify whether there are heterogeneous effects along the student performance distribution.

The EQAO data set also contains information on some characteristics of the individual, including gender, special needs status, gifted status, enrolled in French immersion, and whether the student has English (French) as a second language. In some years, kindergarten attendance was recorded, but it is unfortunately not available for the entire sample period.

Matching schools to neighbourhoods

To the EQAO test score data, we have merged Census data on average socio-economic characteristics of the Forward Sortation Area (fsa) of the school. An fsa comes from the Canadian Postal Code and constitutes the first three digits of the code. We use the school's postal code to get information about its corresponding fsa which is in turn linked to the census. Given that the census occurs every five years, the data for each fsa are linearly interpolated for the years between each census.

The schools in our Ontario dataset are situated in 483 unique FSAs. We have census information for 402 of these, accounting for about 90 percent of all students in the dataset (we have census information for 1,377,093 of 1,534,811 student records). The FSAs in our dataset have an average population of roughly 25,000 people. The FSA Census data includes: average income levels for the FSA, average education levels, percentage speaking French as a home language, and the percentage of the population who are recent immigrants.

Table 4-3 gives summary statistics on the FSA characteristics that we use in our analysis. In order to examine the possibility of heterogeneous effects of full-day kindergarten, we divide FSAs into terciles by each of average income and education levels, and interact an indicator variable for each of the terciles with our main policy variable (Years FDK).

A concern with assigning Census characteristics to a school using the FSA of the school’s postcode not all students attending that school come from the identified fsa.

This is more problematic for French language schools, since they generally have a much larger catchment area than do English language schools. Consequently, we also construct a measure of average socio-economic characteristics for each school using the weighted average of the Census data for each dissemination area (DA) of students' residences. The results using this alternate measure are very similar to those using the simpler school location method, however, and are therefore not reported.

4.4 Methodology

The basis of our methodology lies in the nature of the policy change. In effect, this change gives us a quasi-experiment that is ideal to identify the effect of full-day kindergarten on longer term educational outcomes. We use a difference-in-differences model to estimate the effects of one additional year of full-day kindergarten on test scores, where students at the English boards act as a control group against which to compare the `treated' cohorts in the French boards.

We estimate the following model:

$$S_{ibt} = \alpha + \beta\ YFDK_{ibt} + X_i\,\gamma_1 + FSA_t\,\gamma_2 + B_b\,\tau_1 + Y\,\tau_2 + \epsilon_{ibt}$$

where S_{ibt} is the test score outcome measure for student i in board b in year t. In our baseline model, this is typically an indicator variable equal to 1 if the student achieved the provincial standard (a grade of 3 or 4) on the EQAO test. $YFDK_{ibt}$ is the number of years of full-day kindergarten that student i in board b sitting the test in year t received. As noted earlier, in our baseline specification, $YFDK_{ibt}$ is equal to: 0 for all English language students, and French language students who were of kindergarten age prior to the introduction of full-day kindergarten in the board they attend; 1 for all French language students who would have received 1 year of full-day kindergarten at SK age; and 2 for all French language students who would have received 2 years of full-day kindergarten, at the JK and SK levels. We also examine whether the results are robust to re-defining the policy variable as two separate indicator variables for one year of full-day kindergarten and two years of full-day kindergarten. We also include a range of control variables at the student level, X_i (gender, second language status, and special needs status), and at the school neighbourhood level, FSA_t (including log of deflated average income, percentage new immigrants, percentage with a bachelor's degree, and percentage with a home language of French). B_b' and Y'_t are respectively a full set of board and year fixed effects.

Note that although we have a year dimension, the data are not longitudinal, but consist of pooled cross sections. We estimate the regressions using OLS, with robust standard errors clustered at the school board level.

A key assumption of our empirical strategy is that the timing of the introduction of full-day kindergarten in the French language boards was not influenced by changes in test scores, or by other board-related factors that changed at the same time and could also have influenced test scores. It is important to note first that the French language boards did clearly work together on the introduction of full-day kindergarten. They all also introduced a new curriculum (Pour l'Amour des Nôtres) when they moved to full-day kindergarten – thus our estimates will incorporate the combined effects of a longer day and the new curriculum. This seems reasonable, however, since it is unlikely that a doubling of the school day would be met in any school system without an accompanying modification in the curriculum.

It is also possible, perhaps, that those boards that introduced full-day kindergarten later were those which had greater overall financial pressures. However, any such factors should be accounted for by the inclusion of board fixed effects. There does not appear to be any large change in board's financial prospects that occurred co-incidentally with the introduction of full-day kindergarten.

It is quite clear that the motivation for the introduction of full-day kindergarten lay in a desire to improve French-language schools' performance on the EQAO tests, relative to the English language boards. And indeed, the gap between test performance in the two languages has closed –- and in fact been reversed -- over recent years (see Figure 4-1 to Figure 4-3). This, however, appears to be a result of an overall trend upward in test scores in the French language system, which was apparent prior to the broad introduction of full-day kindergarten in the French system. In order to account for this clear pre-existing trend, we include specifications with a separate quadratic time trend for French-language boards, to allow for the possibility of changes in test scores that were occurring prior to the introduction of full-day kindergarten.

A second and related concern is the possibility of differential selection on the basis of unobservable characteristics of students into schools that offered full-day kindergarten. This has been of particular concern in cross-sectional studies of longer school days, and of studies of the introduction of full-day kindergarten into neighbouring schools in the same school board. As noted, we expect this to be of limited concern here, given that there is likely only a very limited degree of substitutability between English- and French-language schools, particularly given the quite strict application of rules regarding parent's language proficiency in French language schools. This is also supported by evidence we show that there is little reason to think there was any significant change in enrolment levels in French language schools following their moves to full-day kindergarten.

Finally, it may also be argued that English language schools are not an ideal control group for French language schools. As noted, though, most socio-economic characteristics are quite similar and stable across Ontario's Francophone and Anglophone populations. There are only two key differences that we see arising: on geographic location and percentage immigrant. We control for the first issue using board-level fixed effects, but also examine the robustness of the results to including a set of dummies for geographic region. The second issue we deal with by including a control for the percentage of the school's neighbourhood that are recent immigrants.

4.5 Results

We first simply estimate model 1 by OLS, therefore estimating the probability that a student will "pass" the standardized tests for reading, writing, and mathematics. These results are reported in Table 4-4 through Table 4-9 for grade 3 and Table 4-10 through Table 4-15 for grade 6. For each subject, we estimate 13 different specifications for both the grade 3 and grade 6 test results. We provide the results of estimates for the likelihood of achieving a grade of 2 or higher in the grade 3 tests in Appendix Table 4-16 through Appendix Table 4-21.

Grade 3 Reading

Table 4-4 shows the "basic" results for the probability of passing (a score of 3 or higher) the grade 3 reading test, while Table 4-5 provides results once we add a series of interaction variables capturing the impacts of the full-day kindergarten variable on specific groups of individuals.

Looking first at the YFDK variable, we see no evidence of a positive effect of full day kindergarten on the likelihood of passing the grade 3 reading test, regardless of the specification. Another consistent result is that girls outperform boys on the reading tests, although their relative performance was not affected by full-day kindergarten. As expected, ESL and special needs students are significantly less likely to pass the reading test.

There is, however, some evidence of heterogeneous treatment effects (see Table 4-5). We do observe a positive impact of full day kindergarten on students living in areas with higher levels of new immigrants. These heterogeneous treatment effects are observed more strongly in the regressions for a score of 2 or higher. In addition to new immigrants, Appendix Table 4-17 shows a positive effect of full-day kindergarten on the likelihood of achieving at least a score of 2 for special needs students and students living in low income or low education areas.

Grade 3 Writing

Turning now to the grade 3 writing results, Table 4-6 and Table 4-7 show slightly more positive results with respect to full-day kindergarten. There does appear to be a small overall positive impact of full-day kindergarten on the likelihood of passing the writing test, although this impact is only marginally significant (at the 10% level) once we include the French trend variables. Given that we have over 1.2 million observations, we feel that this is a rather weak impact. It would appear that, to the extent that this improvement exists, it is impacting primarily boys, as the relative impact of full-day kindergarten on girls is (marginally) negative. As with reading, however, girls already outperform boys by a large margin on the writing tests.

As with the reading results, we do observe some heterogeneous treatment effects, notably on students living in areas of low income and low education. Appendix Table 4-19 provides similar results for the likelihood of achieving a score of 2 for students in low income and low education areas, although there is no overall improvement.

Grade 3 Mathematics

Table 4-8 and Table 4-9 provide results for the grade 3 mathematics test. This is the first test where girls perform slightly worse than boys, although the difference is substantially smaller than in the reading and writing tests where girls outperformed boys. Once again, we observe no overall effect of full-day kindergarten on the likelihood of passing. The only treatment effect we observe on the likelihood of passing the mathematics test is a negative effect on girls relative to boys. However, the size of these (precisely estimated) effects is smaller than the (imprecisely estimated) overall effects. It therefore seems that boys were helped by full-day kindergarten (rather than girls being hurt), but not enough to give significant overall effects.

Other than the differences by gender, we observe considerably fewer heterogeneous treatments effects for the math test compared to the reading and writing tests. Appendix Table 4-21 does show a positive impact on the likelihood of achieving a score of 2 for students living in areas of low education.

Grade 6 Reading

Given that we saw little overall impact of full-day kindergarten at the grade 3 level, it would be a surprise to see strong impacts on the grade 6 tests. We are not surprised then, that Table 4-10 and Table 4-11 show no overall positive effect of full-day kindergarten on grade 6 reading scores (indeed, a few of the coefficients are negative). Nevertheless, we continue to observe positive effects of full-day kindergarten for children living in areas with a high numbers of new immigrants and areas with low education levels (see Table 4-11).

Grade 6 Writing

The story remains much the same for the writing results. Table 4-12 and Table 4-13 show no overall effect of full-day kindergarten on grade 6 writing tests. Again, however, we observe positive impacts for students living in low income and low education areas, and areas with a large percentage of new immigrants (see Table 4-13).

Grade 6 Math

Finally, and as expected given the grade 3 results, we see no overall impact of full-day kindergarten on grade 6 math scores in Table 4-14 and Table 4-15. Whereas we observed positive effects on students in areas with low education for grade 3, the grade 6 results show a positive impact for students living in low income areas. Naturally, however, low income areas tend to also be areas with low education, so one should not make too much of this change.

4.6 Possible concerns

Student Mobility

A key concern is the potential for mobility between school boards. Research based on either individual or families' choices to attend either full-day or half-day school, or policy changes in relatively integrated school environments, is complicated by the likelihood that selection into either a full-day or a half-day program is not independent of student ability or other confounding (typically family-based) factors. These factors may include the employment status and income of the parents. In this case, if the switch to full-day kindergarten among the French language boards led to an influx of children of less educated parents (to take advantage of cheaper 'daycare'), then we might expect any positive effect on average test scores to be mitigated by a weaker performance among the entering students.

Compared with other similar policy changes, however, mobility is likely to be considerably limited in this case because of the language requirements. The French language schools have a relatively strict policy disallowing students from enrolling unless at least one parent is fluent in French. Consequently, the ability of the vast bulk of Ontario's students to switch into the French language program is quite limited. To validate this, we again draw attention to Table 4-2 and note that enrolment in French language schools was stable during our study period. We have also conducted linear regressions, similar to those conducted in our main analysis, with school enrolments as the dependent variable, and find no significant impact of the change to full-day kindergarten.

<u>The Effect of Treatment on the Treated</u>

Another potential concern is that we can identify the effects of full-day kindergarten in French schools, and therefore we estimate the effect of the treatment on the treated. As a result, we may not be able to generalize this effect to the English school board system. As described above, however, it appears that Ontario Francophones are quite similar to Ontario Anglophones along most dimensions measured in the census, with the exception of their location and their likelihood of being Catholic. We therefore believe that it is reasonable to think that the results would be roughly generalizable to the broader population.

<u>Sensitivity Checks</u>

Beyond the regressions reported here, our results are robust to a series of sensitivity tests. Firstly, we have experimented with included regional fixed effects in addition to the board-level fixed effects. This had virtually no impact on the estimated coefficients.

Since it may take time for teachers to adjust to teaching full-day kindergarten and since full-day junior kindergarten may have a differential impact from senior kindergarten, we have also tried two other specifications. Firstly, we have run the results while excluding those students who only had one year of full-day kindergarten. Secondly, we have run the regressions with separate dummy variables for having completed one year or two years of full-day kindergarten. In this specification, both of the full-day kindergarten variables were insignificant.

4.7 Summary and Discussion

Our results suggest that the move to full-day kindergarten in Ontario's French language school boards had no clear effect on overall test performance in grades 3 and 6, once pre-existing upward trends in French school boards' test scores are taken into account. Nevertheless, we do observe some evidence of heterogeneous treatment effects; namely, students living in areas with high levels of recent immigrants or lower levels of education or income appear to have been helped by the switch to full-day kindergarten. These effects are most noticeable on reading and writing tests (both at grade 3 and 6) but not as evident on math tests.

This pattern of results is consistent with the literature along two dimensions. First, as described in our literature review, while targeted investments in early childhood education have often shown to be effective, the evidence on universal programs is much weaker. It is therefore not surprising to observe small or no impacts on the overall population but positive results for specific targeted groups.

The fact that it is likely students from less wealthy and educated families or immigrant students who benefit from the switch to full-day kindergarten is also consistent with the literature. It is possible that many of these students are from families where French (or English) is less likely to be spoken at home. The additional time in kindergarten may therefore help develop language skills in Canada's official languages. This is consistent with the finding that the effects on test scores are observed more strongly for reading and writing than they are for mathematics.

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Table 4-1 – Start Dates for Full-day Kindergarten

Start dates for Full-Day Kindergarten in French Boards

Board Number	Board Name	Year start JK	Year start SK
B28118	CSD du Grand Nord de l'Ontario	1999/00	1999/00
B29106	CSDC des Grandes Rivières	2001/02	1994/95
B39114	CSDC Franco-Nord	2000/01	1999/00
B29122	CSDC du Nouvel-Ontario	1999/00	1999/00
B29130	CSDC des Aurores boréales	2003/04	1992/93
B66303	CSD du Centre Sud-Ouest	1998/99	1998/99
B66311	CÉP de l'Est de l'Ontario	2002/03	2002/03
B67300	CSD des écoles catholiques du Sud-Ouest	1999/00	1999/00
B67318	CSDC Centre-Sud	1998/99	1998/99
B67326	CSDC de l'Est ontarien	2001/02	2001/02
B67334	Céc du Centre-Est de l'Ontario	2000/01	2000/01
B28100	CSD du Nord-Est de l'Ontario	2000/01	2000/01

Table 4-2 – Years of Full-day Kindergarten

Years of Full-day Kindergarten
Grade 3 Sample, by Years of Full-day Kindergarten

	English Boards	French Boards			
YFDK	0	0	1	2	Total French
1998	137,700	5,890	729	0	6,619
1999	137,518	5,448	735	0	6,183
2000	137,701	6,230	775	0	7,005
2001	139,686	4,645	2,307	0	6,952
2002	138,760	2,810	1,906	1,349	6,065
2003	138,384	1,434	2,202	2,568	6,204
2004	132,721	622	833	4,336	5,791
2005	129,422	0	694	5,309	6,003
2006	127,408	0	30	5,617	5,647
2007	125,690	0	0	6,085	6,085
2008	121,520	0	0	5,747	5,747
Total	1,466,510	27,079	10,211	31,011	68,301

Table 4-3 – Descriptive Statistics for Main Variables

Variable	Description	N	Mean	Std. Dev.	Min	Max
YFDK	Years of full-day kindergarten	1534811	0.047	0.292	0	2
full_JK	Exactly one year of full-day kindergarten	1534811	0.020	0.141	0	1
full_SK	Exactly two years of full-day kindergarten	1534811	0.027	0.162	0	1
Female	Female	1524258	0.489	0.500	0	1
Special needs	Special needs student	1534811	0.071	0.257	0	1
Gifted	Student identified as gifted	1534811	0.003	0.055	0	1
ESL/ELD	ESL/ELD Student	1534811	0.059	0.236	0	1
FSA Log inc.	Log of income in the FSA	1377093	11.119	0.267	10.37	12.54
FSA % with BA	Percentage of FSA having a BA	1377093	22.652	11.033	4.16	66.64
FSA New Imm. %	Percentage of FSA new immigrants (since 1981)	1377093	16.500	14.630	0	59.62
FSA % HLFR	Percentage of FSA with French as home language	1377093	3.262	7.472	0	75.99
FSA % vismin	Percentage of FSA that is visible minority	1377093	22.735	22.678	0	93.39

Table 4-4 – Grade 3 Reading Basic Results

	(1)	(2)	(3)	(4)
Female	0.0860***	0.0860***	0.0860***	0.0860***
	(0.00233)	(0.00233)	(0.00233)	(0.00233)
ESL/ELD	-0.215***	-0.215***	-0.215***	-0.215***
	(0.0182)	(0.0182)	(0.0182)	(0.0182)
Special needs	-0.319***	-0.319***	-0.319***	-0.319***
	(0.0104)	(0.0104)	(0.0104)	(0.0104)
FSA New Imm. %	0.000250	0.000251	0.000254	0.000251
	(0.000841)	(0.000842)	(0.000843)	(0.000842)
FSA % with BA	0.00365***	0.00365***	0.00365***	0.00365***
	(0.000338)	(0.000338)	(0.000338)	(0.000337)
FSA Log Inc.	0.133***	0.133***	0.133***	0.133***
	(0.0148)	(0.0148)	(0.0148)	(0.0148)
FSA % HLFR	-0.00106***	-0.00106***	-0.00105***	-0.00101***
	(0.000275)	(0.000276)	(0.000276)	(0.000284)
FSA % vis. Min	-0.000267	-0.000267	-0.000268	-0.000267
	(0.000489)	(0.000490)	(0.000490)	(0.000489)
YFDK		0.000453	-0.00810	-0.000576
		(0.00660)	(0.0143)	(0.0147)
French Trend			0.00278	-13.84***
			(0.00424)	(2.741)
French Trend Sq.				0.00346***
				(0.000684)
Constant	-0.911***	-0.911***	-1.158***	614.9***
	(0.163)	(0.163)	(0.431)	(122.1)
Observations	1215902	1215902	1215902	1215902
Adjusted R-squared	0.067	0.067	0.067	0.067

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-5 – Grade 3 Reading with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.00431	-0.00307	-0.00942	-0.0257	-0.0279	-0.0403**	-0.0335*
	(0.0155)	(0.0163)	(0.0205)	(0.0213)	(0.0219)	(0.0199)	(0.0191)
YFDK * Female	0.00691	0.00623	0.00627	0.00636	0.00614	0.00626	0.00613
	(0.00450)	(0.00461)	(0.00462)	(0.00459)	(0.00466)	(0.00459)	(0.00464)
Female	0.0856***	0.0857***	0.0857***	0.0857***	0.0857***	0.0857***	0.0857***
	(0.00234)	(0.00235)	(0.00235)	(0.00235)	(0.00235)	(0.00235)	(0.00235)
ESL/ELD	-0.215***	-0.215***	-0.215***	-0.215***	-0.214***	-0.214***	-0.214***
	(0.0182)	(0.0184)	(0.0184)	(0.0184)	(0.0185)	(0.0185)	(0.0185)
Special needs	-0.319***	-0.318***	-0.318***	-0.318***	-0.318***	-0.318***	-0.318***
	(0.0104)	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0108)
FSA New Imm. %	0.000251	0.000250	0.000256	0.000185	0.000228	0.000184	0.000224
	(0.000841)	(0.000841)	(0.000839)	(0.000848)	(0.000845)	(0.000849)	(0.000845)
FSA % with BA	0.00365***	0.00365***	0.00365***	0.00364***	0.00360***	0.00365***	0.00361***
	(0.000337)	(0.000337)	(0.000338)	(0.000339)	(0.000338)	(0.000341)	(0.000341)
FSA Log Inc.	0.133***	0.133***	0.133***	0.132***	0.135***	0.132***	0.135***
	(0.0148)	(0.0148)	(0.0148)	(0.0147)	(0.0146)	(0.0147)	(0.0147)
FSA % HLFR	-0.00101***	-0.00101***	-0.00111***	-0.00115***	-0.00114***	-0.00116***	-0.00115***
	(0.000284)	(0.000285)	(0.000266)	(0.000262)	(0.000261)	(0.000260)	(0.000259)
FSA % vis. Min	-0.000267	-0.000267	-0.000270	-0.000263	-0.000276	-0.000263	-0.000276
	(0.000489)	(0.000489)	(0.000489)	(0.000492)	(0.000492)	(0.000492)	(0.000491)
French Trend	-13.87***	-14.00***	-13.90***	-13.84***	-13.98***	-14.19***	-14.10***
	(2.737)	(2.820)	(2.846)	(2.776)	(2.801)	(2.940)	(2.889)
French Trend Sq.	0.00346***	0.00350***	0.00347***	0.00346***	0.00349***	0.00354***	0.00352***
	(0.000683)	(0.000704)	(0.000710)	(0.000692)	(0.000699)	(0.000733)	(0.000721)
YFDK * Special Needs		-0.0130	-0.0135	-0.0132	-0.0137	-0.0135	-0.0138
		(0.00989)	(0.00986)	(0.00989)	(0.0105)	(0.0102)	(0.0106)
YFDK * ESL/ELD		-0.00730	-0.00607	-0.00486	-0.00902	-0.00711	-0.00906
		(0.0286)	(0.0295)	(0.0304)	(0.0281)	(0.0299)	(0.0283)

YFDK * FSA % HLFR			0.000405	0.000652*	0.000465	0.000668**	0.000501*
			(0.000324)	(0.000336)	(0.000322)	(0.000288)	(0.000295)
YFDK * FSA % New Imm				0.00121***	0.00123**	0.00164***	0.00142**
				(0.000441)	(0.000468)	(0.000406)	(0.000547)
YFDK * FSA Low Inc					0.0238**		0.0206
					(0.0116)		(0.0142)
YFDK * FSA % Med Inc					-0.00377		-0.00616
					(0.00676)		(0.00804)
YFDK * FSA % Low Ed						0.0197**	0.00729
						(0.00979)	(0.0129)
YFDK * FSA % Med Ed						0.0146	0.0108**
						(0.00908)	(0.00513)
Constant	616.0***	621.9***	617.3***	614.9***	621.0***	630.4***	626.3***
	(121.9)	(125.6)	(126.7)	(123.6)	(124.7)	(130.9)	(128.6)
Observations	1215902	1215902	1215902	1215902	1215902	1215902	1215902
Adjusted R-squared	0.067	0.067	0.067	0.067	0.067	0.067	0.067

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-6 – Grade 3 Writing Basic Results

	(1)	(2)	(3)	(4)
Female	0.136***	0.136***	0.136***	0.136***
	(0.00412)	(0.00412)	(0.00412)	(0.00412)
ESL/ELD	-0.157***	-0.156***	-0.156***	-0.156***
	(0.0162)	(0.0164)	(0.0164)	(0.0164)
Special needs	-0.307***	-0.307***	-0.307***	-0.307***
	(0.0134)	(0.0134)	(0.0134)	(0.0134)
FSA New Imm. %	0.00221***	0.00224***	0.00225***	0.00225***
	(0.000781)	(0.000776)	(0.000776)	(0.000776)
FSA % with BA	0.00261***	0.00261***	0.00261***	0.00261***
	(0.000315)	(0.000313)	(0.000313)	(0.000313)
FSA Log Inc.	0.150***	0.150***	0.150***	0.150***
	(0.0128)	(0.0128)	(0.0128)	(0.0128)
FSA % HLFR	-0.000884***	-0.000793***	-0.000788***	-0.000793***
	(0.000229)	(0.000241)	(0.000244)	(0.000242)
FSA % vis. min	-0.000337	-0.000351	-0.000352	-0.000352
	(0.000460)	(0.000457)	(0.000457)	(0.000457)
YFDK		0.0322***	0.0207*	0.0196*
		(0.00780)	(0.0114)	(0.0109)
French Trend			0.00374	1.997
			(0.00333)	(1.644)
French Trend Sq.				-0.000498
				(0.000410)
Constant	-1.069***	-1.075***	-1.404***	-89.06
	(0.140)	(0.140)	(0.311)	(72.34)
Observations	1238474	1238474	1238474	1238474
Adjusted R-squared	0.080	0.080	0.080	0.080

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-7 – Grade 3 Writing with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	0.0249**	0.0253**	0.0175	0.0155	0.0104	-0.00362	0.00157
	(0.0114)	(0.0121)	(0.0170)	(0.0179)	(0.0199)	(0.0159)	(0.0174)
YFDK * Female	-0.00976*	-0.00915*	-0.00910*	-0.00909*	-0.00933*	-0.00923*	-0.00935*
	(0.00505)	(0.00504)	(0.00505)	(0.00504)	(0.00513)	(0.00504)	(0.00512)
Female	0.137***	0.137***	0.137***	0.137***	0.137***	0.137***	0.137***
	(0.00426)	(0.00427)	(0.00427)	(0.00427)	(0.00427)	(0.00427)	(0.00427)
ESL/ELD	-0.156***	-0.156***	-0.156***	-0.156***	-0.155***	-0.156***	-0.155***
	(0.0164)	(0.0166)	(0.0166)	(0.0166)	(0.0166)	(0.0166)	(0.0166)
Special needs	-0.307***	-0.308***	-0.308***	-0.308***	-0.308***	-0.308***	-0.308***
	(0.0134)	(0.0138)	(0.0138)	(0.0138)	(0.0138)	(0.0138)	(0.0138)
FSA New Imm. %	0.00225***	0.00224***	0.00225***	0.00224***	0.00229***	0.00224***	0.00228***
	(0.000776)	(0.000776)	(0.000775)	(0.000776)	(0.000773)	(0.000777)	(0.000773)
FSA % with BA	0.00261***	0.00261***	0.00261***	0.00261***	0.00258***	0.00263***	0.00260***
	(0.000313)	(0.000313)	(0.000313)	(0.000314)	(0.000313)	(0.000316)	(0.000317)
FSA Log Inc.	0.150***	0.150***	0.150***	0.150***	0.153***	0.151***	0.153***
	(0.0128)	(0.0128)	(0.0128)	(0.0127)	(0.0128)	(0.0127)	(0.0128)
FSA % HLFR	-0.000794***	-0.000800***	-0.000913***	-0.000918***	-0.000912***	-0.000931***	-0.000927***
	(0.000242)	(0.000242)	(0.000223)	(0.000228)	(0.000226)	(0.000227)	(0.000225)
FSA % vis. min	-0.000352	-0.000351	-0.000355	-0.000354	-0.000368	-0.000354	-0.000366
	(0.000457)	(0.000457)	(0.000457)	(0.000457)	(0.000458)	(0.000458)	(0.000457)
French Trend	2.029	2.461	2.588	2.599	2.439	2.133	2.217
	(1.644)	(1.653)	(1.683)	(1.688)	(1.736)	(1.684)	(1.701)
French Trend Sq.	-0.000505	-0.000613	-0.000645	-0.000648	-0.000608	-0.000532	-0.000553
	(0.000410)	(0.000412)	(0.000420)	(0.000421)	(0.000433)	(0.000420)	(0.000424)
YFDK * Special Needs		0.0145	0.0139	0.0139	0.0132	0.0135	0.0132
		(0.0110)	(0.0111)	(0.0110)	(0.0105)	(0.0108)	(0.0105)
YFDK * ESL/ELD		-0.0264	-0.0249	-0.0247	-0.0288	-0.0275	-0.0292
		(0.0233)	(0.0238)	(0.0238)	(0.0215)	(0.0227)	(0.0213)

YFDK * FSA % HLFR			0.000494	0.000524	0.000361	0.000546	0.000406
			(0.000362)	(0.000405)	(0.000439)	(0.000370)	(0.000418)
YFDK * FSA % New Imm				0.000150	0.000185	0.000716**	0.000514
				(0.000439)	(0.000449)	(0.000282)	(0.000401)
YFDK * FSA Low Inc					0.0256***		0.0191*
					(0.00953)		(0.00998)
YFDK * FSA % Med Inc					0.000586		-0.00366
					(0.00726)		(0.00788)
YFDK * FSA % Low Ed						0.0259***	0.0143**
						(0.00712)	(0.00681)
YFDK * FSA % Med Ed						0.0193***	0.0154**
						(0.00714)	(0.00649)
Constant	-90.44	-109.4	-115.0	-115.5	-108.5	-95.01	-98.72
	(72.34)	(72.75)	(74.05)	(74.29)	(76.39)	(74.10)	(74.83)
Observations	1238474	1238474	1238474	1238474	1238474	1238474	1238474
Adjusted R-squared	0.080	0.080	0.080	0.080	0.080	0.080	0.080

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-8 – Grade 3 Math Basic Results

	(1)	(2)	(3)	(4)
Female	-0.00675***	-0.00675***	-0.00674***	-0.00673***
	(0.00133)	(0.00132)	(0.00132)	(0.00132)
ESL/ELD	-0.132***	-0.131***	-0.131***	-0.131***
	(0.0126)	(0.0126)	(0.0126)	(0.0126)
Special needs	-0.283***	-0.283***	-0.283***	-0.283***
	(0.0106)	(0.0106)	(0.0106)	(0.0106)
FSA New Imm. %	0.00130	0.00134	0.00135	0.00135
	(0.00117)	(0.00116)	(0.00116)	(0.00116)
FSA % with BA	0.00313***	0.00313***	0.00313***	0.00313***
	(0.000426)	(0.000424)	(0.000424)	(0.000424)
FSA Log Inc.	0.152***	0.152***	0.152***	0.152***
	(0.0180)	(0.0180)	(0.0180)	(0.0180)
FSA % HLFR	-0.00117***	-0.00106***	-0.00105***	-0.00104***
	(0.000366)	(0.000365)	(0.000365)	(0.000367)
FSA % vis. Min	-0.000729	-0.000745	-0.000749	-0.000749
	(0.000634)	(0.000630)	(0.000630)	(0.000630)
YFDK		0.0415***	0.0177	0.0183
		(0.00756)	(0.0147)	(0.0161)
French Trend			0.00771*	-1.126
			(0.00405)	(4.096)
French Trend Sq.				0.000283
				(0.00102)
Constant	-0.992***	-1.000***	-1.665***	47.13
	(0.193)	(0.193)	(0.381)	(176.4)
Observations	1274088	1274088	1274088	1274088
Adjusted R-squared	0.054	0.055	0.055	0.055

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-9 – Grade 3 Math with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	0.0260	0.0280	0.0249	0.0229	0.0259	0.0147	0.0232
	(0.0165)	(0.0175)	(0.0203)	(0.0218)	(0.0236)	(0.0189)	(0.0185)
YFDK * Female	-0.0143***	-0.0148***	-0.0147***	-0.0147***	-0.0148***	-0.0148***	-0.0148***
	(0.00398)	(0.00402)	(0.00403)	(0.00400)	(0.00398)	(0.00404)	(0.00398)
Female	-0.00606***	-0.00604***	-0.00604***	-0.00604***	-0.00604***	-0.00604***	-0.00604***
	(0.00131)	(0.00131)	(0.00131)	(0.00131)	(0.00131)	(0.00131)	(0.00131)
ESL/ELD	-0.131***	-0.130***	-0.130***	-0.130***	-0.130***	-0.130***	-0.130***
	(0.0126)	(0.0127)	(0.0127)	(0.0127)	(0.0127)	(0.0127)	(0.0127)
Special needs	-0.283***	-0.282***	-0.282***	-0.282***	-0.282***	-0.282***	-0.282***
	(0.0106)	(0.0110)	(0.0110)	(0.0110)	(0.0110)	(0.0110)	(0.0110)
FSA New Imm. %	0.00135	0.00135	0.00135	0.00134	0.00137	0.00134	0.00136
	(0.00116)	(0.00116)	(0.00116)	(0.00116)	(0.00116)	(0.00116)	(0.00116)
FSA % with BA	0.00313***	0.00313***	0.00313***	0.00313***	0.00310***	0.00313***	0.00311***
	(0.000424)	(0.000424)	(0.000424)	(0.000426)	(0.000427)	(0.000425)	(0.000426)
FSA Log Inc.	0.152***	0.152***	0.152***	0.152***	0.154***	0.152***	0.154***
	(0.0180)	(0.0180)	(0.0180)	(0.0179)	(0.0182)	(0.0180)	(0.0181)
FSA % HLFR	-0.00105***	-0.00105***	-0.00110***	-0.00110***	-0.00110***	-0.00110***	-0.00111***
	(0.000367)	(0.000367)	(0.000391)	(0.000392)	(0.000391)	(0.000391)	(0.000389)
FSA % vis. Min	-0.000748	-0.000747	-0.000749	-0.000748	-0.000758	-0.000746	-0.000754
	(0.000630)	(0.000630)	(0.000630)	(0.000630)	(0.000629)	(0.000630)	(0.000629)
French Trend	-1.082	-0.928	-0.875	-0.868	-0.975	-1.150	-1.112
	(4.101)	(4.132)	(4.148)	(4.147)	(4.169)	(4.261)	(4.217)
French Trend Sq.	0.000272	0.000233	0.000220	0.000218	0.000245	0.000289	0.000279
	(0.00102)	(0.00103)	(0.00104)	(0.00103)	(0.00104)	(0.00106)	(0.00105)
YFDK * Special Needs		-0.00605	-0.00629	-0.00624	-0.00651	-0.00634	-0.00640
		(0.00901)	(0.00906)	(0.00911)	(0.00899)	(0.00909)	(0.00902)
YFDK * ESL/ELD		-0.0295	-0.0289	-0.0288	-0.0321	-0.0314	-0.0330
		(0.0274)	(0.0280)	(0.0279)	(0.0250)	(0.0284)	(0.0260)

YFDK * FSA % HLFR			0.000199	0.000229	0.0000340	0.000189	0.0000242
			(0.000245)	(0.000244)	(0.000231)	(0.000236)	(0.000221)
YFDK * FSA % New Imm				0.000144	0.000139	0.000431	0.000294
				(0.000577)	(0.000595)	(0.000725)	(0.000895)
YFDK * FSA Low Inc					0.0166		0.0118
					(0.0108)		(0.0210)
YFDK * FSA % Med Inc					-0.0107		-0.0129
					(0.0105)		(0.0158)
YFDK * FSA % Low Ed						0.0168	0.00982
						(0.0164)	(0.0275)
YFDK * FSA % Med Ed						0.00209	0.00114
						(0.00964)	(0.0163)
Constant	45.24	38.63	36.33	36.04	40.64	48.18	46.52
	(176.7)	(178.0)	(178.7)	(178.6)	(179.6)	(183.5)	(181.6)
Observations	1274088	1274088	1274088	1274088	1274088	1274088	1274088
Adjusted R-squared	0.055	0.055	0.055	0.055	0.055	0.055	0.055

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-10 – Grade 6 Reading Basic Results

	(1)	(2)	(3)	(4)
Female	0.108***	0.108***	0.108***	0.108***
	(0.00238)	(0.00238)	(0.00238)	(0.00238)
ESL/ELD	-0.259***	-0.259***	-0.259***	-0.259***
	(0.0225)	(0.0225)	(0.0224)	(0.0225)
Special needs	-0.339***	-0.339***	-0.339***	-0.339***
	(0.00789)	(0.00790)	(0.00790)	(0.00790)
FSA New Imm. %	0.000164	0.000163	0.000157	0.000159
	(0.00113)	(0.00113)	(0.00113)	(0.00113)
FSA % with BA	0.00448***	0.00448***	0.00447***	0.00448***
	(0.000371)	(0.000371)	(0.000371)	(0.000371)
FSA Log Inc.	0.117***	0.117***	0.117***	0.117***
	(0.0138)	(0.0138)	(0.0138)	(0.0138)
FSA % HLFR	-0.000579*	-0.000581*	-0.000592*	-0.000558*
	(0.000300)	(0.000303)	(0.000305)	(0.000315)
FSA % vis. min	-0.000245	-0.000245	-0.000243	-0.000243
	(0.000628)	(0.000629)	(0.000630)	(0.000630)
YFDK		-0.000961	0.00854	-0.0206*
		(0.00744)	(0.00674)	(0.0107)
French Trend			-0.00311	-11.32***
			(0.00250)	(2.529)
French Trend Sq.				0.00283***
				(0.000632)
Constant	-0.669***	-0.669***	-0.426*	441.6***
	(0.152)	(0.152)	(0.251)	(98.78)
Observations	1323233	1323233	1323233	1323233
Adjusted R-squared	0.099	0.099	0.099	0.099

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-11 – Grade 6 Reading with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.0152	-0.0146	-0.0197	-0.0279	-0.0424**	-0.0603**	-0.0594***
	(0.0122)	(0.0126)	(0.0176)	(0.0174)	(0.0200)	(0.0244)	(0.0211)
YFDK * Female	-0.0102	-0.0106*	-0.0106	-0.0105	-0.0108	-0.0108*	-0.0109*
	(0.00674)	(0.00638)	(0.00650)	(0.00647)	(0.00654)	(0.00644)	(0.00652)
Female	0.109***	0.109***	0.109***	0.109***	0.109***	0.109***	0.109***
	(0.00243)	(0.00243)	(0.00243)	(0.00243)	(0.00243)	(0.00243)	(0.00243)
ESL/ELD	-0.259***	-0.259***	-0.259***	-0.258***	-0.258***	-0.258***	-0.258***
	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0225)
Special needs	-0.339***	-0.339***	-0.339***	-0.339***	-0.339***	-0.339***	-0.339***
	(0.00790)	(0.00799)	(0.00799)	(0.00799)	(0.00799)	(0.00799)	(0.00799)
FSA New Imm. %	0.000159	0.000159	0.000162	0.000146	0.000171	0.000147	0.000167
	(0.00113)	(0.00113)	(0.00113)	(0.00113)	(0.00113)	(0.00114)	(0.00113)
FSA % with BA	0.00448***	0.00448***	0.00448***	0.00447***	0.00446***	0.00449***	0.00447***
	(0.000371)	(0.000371)	(0.000371)	(0.000372)	(0.000371)	(0.000374)	(0.000373)
FSA Log Inc.	0.117***	0.117***	0.116***	0.116***	0.118***	0.117***	0.118***
	(0.0138)	(0.0138)	(0.0138)	(0.0138)	(0.0137)	(0.0137)	(0.0138)
FSA % HLFR	-0.000558*	-0.000557*	-0.000606**	-0.000619**	-0.000608**	-0.000632**	-0.000625**
	(0.000315)	(0.000315)	(0.000300)	(0.000300)	(0.000300)	(0.000304)	(0.000302)
FSA % vis. min	-0.000243	-0.000243	-0.000245	-0.000243	-0.000251	-0.000245	-0.000251
	(0.000630)	(0.000630)	(0.000629)	(0.000630)	(0.000630)	(0.000630)	(0.000629)
French Trend	-11.28***	-11.38***	-11.18***	-11.26***	-11.58***	-11.92***	-11.92***
	(2.526)	(2.618)	(2.579)	(2.614)	(2.560)	(2.433)	(2.436)
French Trend Sq.	0.00282***	0.00284***	0.00279***	0.00281***	0.00289***	0.00298***	0.00298***
	(0.000631)	(0.000654)	(0.000644)	(0.000653)	(0.000640)	(0.000608)	(0.000609)
YFDK * Special Needs		-0.00517	-0.00561	-0.00525	-0.00695	-0.00595	-0.00702
		(0.0143)	(0.0142)	(0.0140)	(0.0132)	(0.0138)	(0.0132)
YFDK * ESL/ELD		0.0122	0.0143	0.0148	0.00503	0.0118	0.00417
		(0.0333)	(0.0354)	(0.0353)	(0.0319)	(0.0343)	(0.0315)

YFDK * FSA % HLFR			0.000495	0.000634	0.000523	0.000729*	0.000630*
			(0.000475)	(0.000466)	(0.000429)	(0.000382)	(0.000357)
YFDK * FSA % New Imm				0.000531**	0.000641**	0.00139***	0.00117***
				(0.000265)	(0.000280)	(0.000505)	(0.000404)
YFDK * FSA Low Inc					0.0357**		0.0260
					(0.0167)		(0.0168)
YFDK * FSA % Med Inc					0.0109*		0.00413
					(0.00647)		(0.00737)
YFDK * FSA % Low Ed						0.0379**	0.0235*
						(0.0155)	(0.0134)
YFDK * FSA % Med Ed						0.0303**	0.0250**
						(0.0144)	(0.0114)
Constant	440.2***	444.2***	436.4***	439.2***	451.6***	465.2***	465.0***
	(98.65)	(102.3)	(100.8)	(102.1)	(99.98)	(95.03)	(95.15)
Observations	1323233	1323233	1323233	1323233	1323233	1323233	1323233
Adjusted R-squared	0.099	0.099	0.099	0.099	0.100	0.100	0.100

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-12 – Grade 6 Writing Basic Results

	(1)	(2)	(3)	(4)
Female	0.174***	0.174***	0.174***	0.174***
	(0.00419)	(0.00419)	(0.00419)	(0.00419)
ESL/ELD	-0.226***	-0.226***	-0.225***	-0.225***
	(0.0252)	(0.0252)	(0.0252)	(0.0252)
Special needs	-0.349***	-0.349***	-0.349***	-0.349***
	(0.00681)	(0.00681)	(0.00681)	(0.00681)
FSA New Imm. %	0.00163*	0.00163*	0.00164*	0.00164*
	(0.000833)	(0.000833)	(0.000831)	(0.000831)
FSA % with BA	0.00410***	0.00410***	0.00410***	0.00410***
	(0.000327)	(0.000327)	(0.000327)	(0.000327)
FSA Log Inc.	0.125***	0.125***	0.125***	0.125***
	(0.0139)	(0.0139)	(0.0139)	(0.0139)
FSA % HLFR	-0.000448*	-0.000445*	-0.000426	-0.000428
	(0.000261)	(0.000262)	(0.000264)	(0.000268)
FSA % vis. min	-0.000309	-0.000309	-0.000313	-0.000313
	(0.000517)	(0.000517)	(0.000516)	(0.000516)
YFDK		0.00160	-0.0149**	-0.0139*
		(0.00716)	(0.00733)	(0.00820)
French Trend			0.00542***	0.400
			(0.00174)	(2.461)
French Trend Sq.				-0.0000985
				(0.000615)
Constant	-0.827***	-0.827***	-1.250***	-16.58
	(0.151)	(0.151)	(0.201)	(95.63)
Observations	1329294	1329294	1329294	1329294
Adjusted R-squared	0.125	0.125	0.125	0.125

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-13 – Grade 6 Writing with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.00419	-0.00446	-0.00542	-0.00891	-0.0237	-0.0423**	-0.0417**
	(0.0117)	(0.0124)	(0.0147)	(0.0164)	(0.0169)	(0.0185)	(0.0171)
YFDK * Female	-0.0181*	-0.0178*	-0.0178*	-0.0177*	-0.0180*	-0.0181*	-0.0181*
	(0.00927)	(0.00907)	(0.00910)	(0.00911)	(0.00920)	(0.00909)	(0.00916)
Female	0.174***	0.174***	0.174***	0.174***	0.174***	0.174***	0.174***
	(0.00428)	(0.00428)	(0.00428)	(0.00428)	(0.00428)	(0.00428)	(0.00428)
ESL/ELD	-0.225***	-0.225***	-0.225***	-0.225***	-0.225***	-0.225***	-0.225***
	(0.0252)	(0.0253)	(0.0253)	(0.0253)	(0.0253)	(0.0253)	(0.0253)
Special needs	-0.349***	-0.349***	-0.349***	-0.349***	-0.349***	-0.349***	-0.349***
	(0.00680)	(0.00685)	(0.00685)	(0.00685)	(0.00685)	(0.00685)	(0.00685)
FSA New Imm. %	0.00164*	0.00164*	0.00164*	0.00163*	0.00166*	0.00163*	0.00165*
	(0.000832)	(0.000832)	(0.000832)	(0.000834)	(0.000833)	(0.000835)	(0.000833)
FSA % with BA	0.00410***	0.00410***	0.00410***	0.00410***	0.00408***	0.00411***	0.00410***
	(0.000327)	(0.000327)	(0.000327)	(0.000327)	(0.000327)	(0.000327)	(0.000328)
FSA Log Inc.	0.125***	0.125***	0.125***	0.125***	0.126***	0.125***	0.126***
	(0.0139)	(0.0139)	(0.0139)	(0.0138)	(0.0139)	(0.0138)	(0.0139)
FSA % HLFR	-0.000428	-0.000428	-0.000437*	-0.000443*	-0.000432*	-0.000455*	-0.000448*
	(0.000268)	(0.000268)	(0.000258)	(0.000258)	(0.000259)	(0.000259)	(0.000258)
FSA % vis. min	-0.000313	-0.000313	-0.000313	-0.000312	-0.000319	-0.000313	-0.000319
	(0.000516)	(0.000516)	(0.000516)	(0.000517)	(0.000517)	(0.000517)	(0.000517)
French Trend	0.468	0.568	0.603	0.572	0.257	-0.135	-0.133
	(2.467)	(2.468)	(2.424)	(2.440)	(2.383)	(2.237)	(2.247)
French Trend Sq.	-0.000116	-0.000140	-0.000149	-0.000141	-0.0000629	0.0000351	0.0000345
	(0.000616)	(0.000617)	(0.000605)	(0.000609)	(0.000595)	(0.000559)	(0.000561)
YFDK * Special Needs		0.00362	0.00353	0.00370	0.00205	0.00299	0.00206
		(0.0160)	(0.0159)	(0.0159)	(0.0152)	(0.0158)	(0.0153)
YFDK * ESL/ELD		-0.0227	-0.0223	-0.0221	-0.0313	-0.0247	-0.0311
		(0.0220)	(0.0220)	(0.0220)	(0.0233)	(0.0222)	(0.0234)

YFDK * FSA % HLFR			0.0000919	0.000151	0.0000545	0.000222	0.000142
			(0.000314)	(0.000344)	(0.000335)	(0.000257)	(0.000265)
YFDK * FSA % New Imm				0.000227	0.000339	0.00113***	0.000949***
				(0.000262)	(0.000217)	(0.000330)	(0.000265)
YFDK * FSA Low Inc					0.0345***		0.0222*
					(0.0125)		(0.0117)
YFDK * FSA % Med Inc					0.0118**		0.00400
					(0.00512)		(0.00523)
YFDK * FSA % Low Ed						0.0415***	0.0292***
						(0.0115)	(0.00963)
YFDK * FSA % Med Ed						0.0290**	0.0244**
						(0.0117)	(0.0103)
Constant	-19.22	-23.10	-24.45	-23.26	-11.04	4.223	4.132
	(95.87)	(95.93)	(94.22)	(94.84)	(92.62)	(86.95)	(87.31)
Observations	1329294	1329294	1329294	1329294	1329294	1329294	1329294
Adjusted R-squared	0.125	0.125	0.125	0.125	0.125	0.125	0.125

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-14 – Grade 6 Math Basic Results

	(1)	(2)	(3)	(4)
Female	-0.00281**	-0.00281**	-0.00282**	-0.00282**
	(0.00140)	(0.00140)	(0.00140)	(0.00140)
ESL/ELD	-0.126***	-0.126***	-0.125***	-0.125***
	(0.0188)	(0.0188)	(0.0189)	(0.0189)
Special needs	-0.321***	-0.321***	-0.321***	-0.321***
	(0.00984)	(0.00984)	(0.00983)	(0.00984)
FSA New Imm. %	0.00190	0.00191	0.00194	0.00194
	(0.00126)	(0.00125)	(0.00125)	(0.00125)
FSA % with BA	0.00458***	0.00458***	0.00458***	0.00458***
	(0.000389)	(0.000388)	(0.000387)	(0.000387)
FSA Log Inc.	0.151***	0.151***	0.151***	0.151***
	(0.0163)	(0.0163)	(0.0162)	(0.0162)
FSA % HLFR	-0.000558**	-0.000517**	-0.000474**	-0.000481**
	(0.000220)	(0.000215)	(0.000221)	(0.000222)
FSA % vis. min	-0.000700	-0.000703	-0.000711	-0.000711
	(0.000663)	(0.000662)	(0.000660)	(0.000660)
YFDK		0.0247***	-0.0122	-0.00607
		(0.00738)	(0.0109)	(0.0117)
French Trend			0.0121***	2.398
			(0.00371)	(1.631)
French Trend Sq.				-0.000596
				(0.000407)
Constant	-1.091***	-1.092***	-2.037***	-95.00
	(0.179)	(0.179)	(0.336)	(63.59)
Observations	1326487	1326487	1326487	1326487
Adjusted R-squared	0.076	0.076	0.076	0.076

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Table 4-15 – Grade 6 Math with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.00325	-0.00350	-0.00716	-0.00339	-0.0228	-0.0268	-0.0305**
	(0.0117)	(0.0117)	(0.0146)	(0.0191)	(0.0200)	(0.0186)	(0.0145)
YFDK * Female	-0.00528	-0.00491	-0.00485	-0.00489	-0.00519	-0.00512	-0.00525
	(0.00493)	(0.00420)	(0.00424)	(0.00427)	(0.00435)	(0.00435)	(0.00438)
Female	-0.00270*	-0.00270*	-0.00270*	-0.00270*	-0.00270*	-0.00270*	-0.00270*
	(0.00142)	(0.00142)	(0.00142)	(0.00142)	(0.00142)	(0.00142)	(0.00142)
ESL/ELD	-0.125***	-0.125***	-0.125***	-0.125***	-0.125***	-0.125***	-0.125***
	(0.0189)	(0.0189)	(0.0189)	(0.0189)	(0.0189)	(0.0189)	(0.0189)
Special needs	-0.321***	-0.321***	-0.321***	-0.321***	-0.321***	-0.321***	-0.321***
	(0.00983)	(0.00992)	(0.00993)	(0.00992)	(0.00992)	(0.00992)	(0.00992)
FSA New Imm. %	0.00194	0.00194	0.00194	0.00195	0.00197	0.00195	0.00197
	(0.00125)	(0.00125)	(0.00125)	(0.00125)	(0.00125)	(0.00125)	(0.00125)
FSA % with BA	0.00458***	0.00458***	0.00458***	0.00459***	0.00457***	0.00459***	0.00457***
	(0.000387)	(0.000387)	(0.000387)	(0.000387)	(0.000387)	(0.000387)	(0.000388)
FSA Log Inc.	0.151***	0.151***	0.151***	0.151***	0.152***	0.151***	0.152***
	(0.0162)	(0.0162)	(0.0163)	(0.0163)	(0.0163)	(0.0163)	(0.0163)
FSA % HLFR	-0.000481**	-0.000482**	-0.000516**	-0.000511**	-0.000498**	-0.000519**	-0.000506**
	(0.000222)	(0.000222)	(0.000222)	(0.000223)	(0.000224)	(0.000226)	(0.000225)
FSA % vis. min	-0.000711	-0.000711	-0.000712	-0.000713	-0.000720	-0.000713	-0.000720
	(0.000660)	(0.000660)	(0.000659)	(0.000659)	(0.000659)	(0.000659)	(0.000659)
French Trend	2.416	2.547	2.688*	2.721*	2.357	2.222	2.206
	(1.631)	(1.602)	(1.569)	(1.591)	(1.660)	(1.695)	(1.671)
French Trend Sq.	-0.000600	-0.000633	-0.000668*	-0.000676*	-0.000586	-0.000552	-0.000548
	(0.000407)	(0.000400)	(0.000392)	(0.000397)	(0.000414)	(0.000423)	(0.000417)
YFDK * Special Needs		0.00428	0.00399	0.00379	0.00214	0.00331	0.00211
		(0.0193)	(0.0190)	(0.0191)	(0.0186)	(0.0190)	(0.0186)
YFDK * ESL/ELD		-0.0325	-0.0310	-0.0310	-0.0398	-0.0326	-0.0402
		(0.0307)	(0.0320)	(0.0319)	(0.0300)	(0.0315)	(0.0296)

YFDK * FSA % HLFR			0.000351	0.000287	0.000221	0.000332	0.000271
			(0.000262)	(0.000350)	(0.000370)	(0.000394)	(0.000367)
YFDK * FSA % New Imm				-0.000245	-0.0000941	0.000392	0.000141
				(0.000435)	(0.000439)	(0.000523)	(0.000418)
YFDK * FSA Low Inc					0.0382***		0.0340*
					(0.0135)		(0.0184)
YFDK * FSA % Med Inc					0.0179***		0.0149**
					(0.00535)		(0.00726)
YFDK * FSA % Low Ed						0.0295**	0.0102
						(0.0118)	(0.0179)
YFDK * FSA % Med Ed						0.0198*	0.0114
						(0.0104)	(0.0116)
Constant	-95.68	-100.8	-106.3*	-107.6*	-93.40	-88.14	-87.54
	(63.59)	(62.44)	(61.15)	(62.01)	(64.70)	(66.08)	(65.13)
Observations	1326487	1326487	1326487	1326487	1326487	1326487	1326487
Adjusted R-squared	0.076	0.076	0.076	0.076	0.076	0.076	0.076

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Figure 4-1– Percentage of Students Passing Grade 3 Reading Test

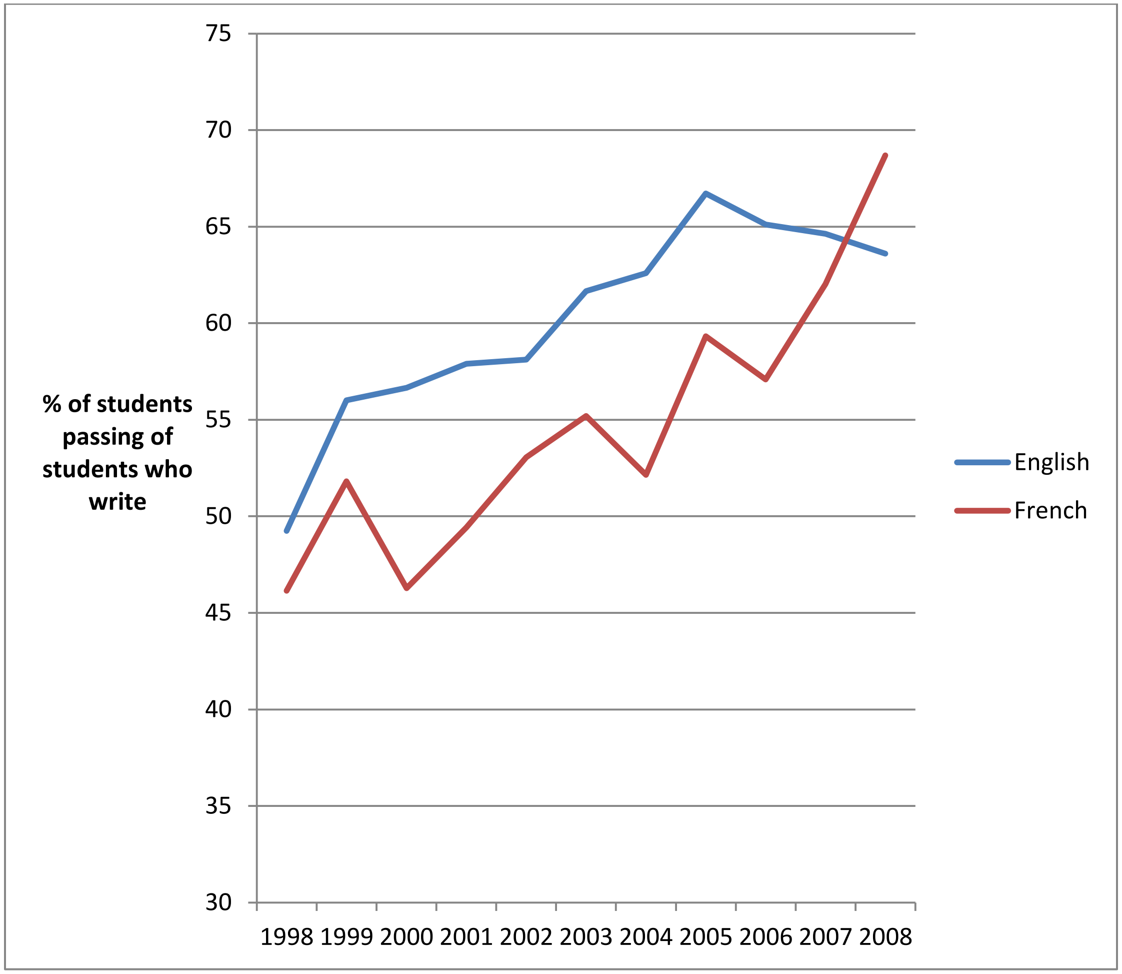


Figure 4-2 – Percentage of Students Passing Grade 3 Writing Test

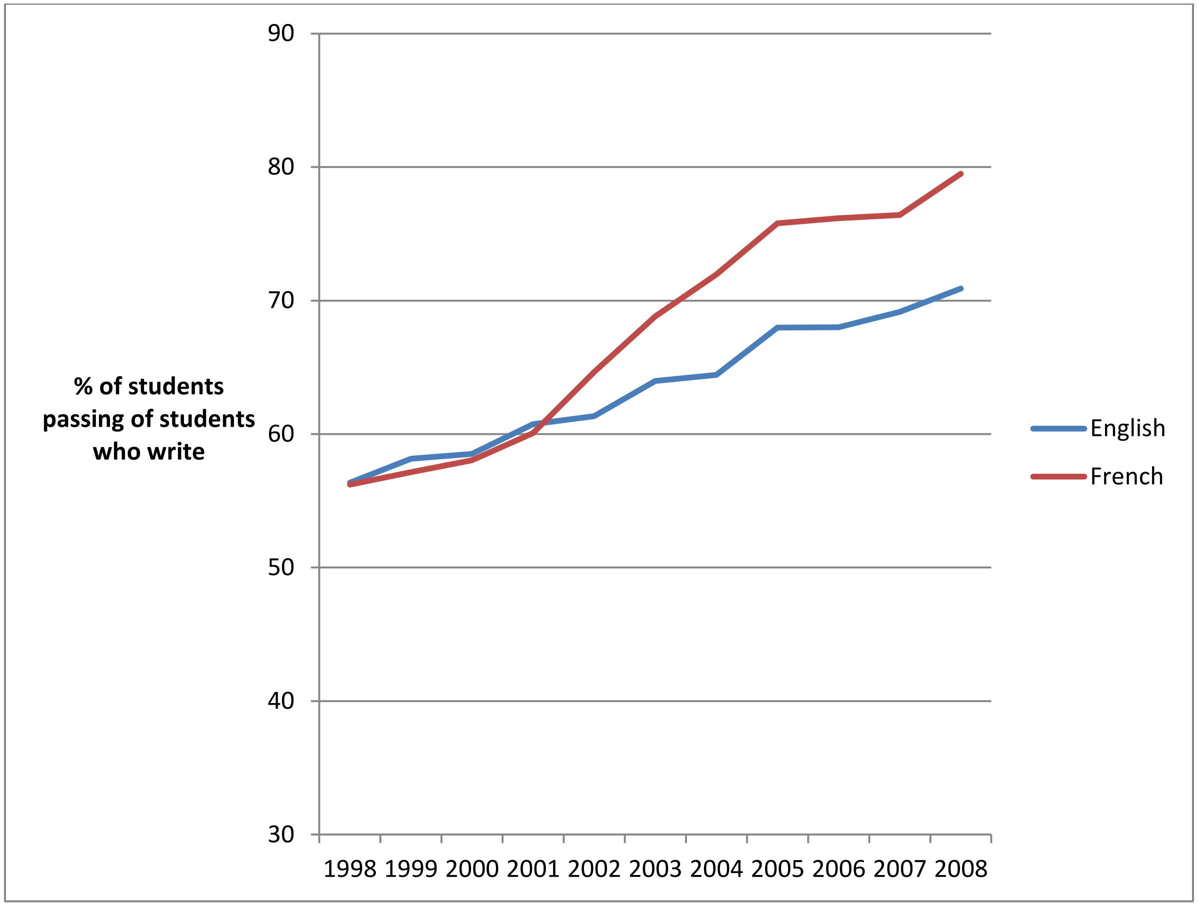
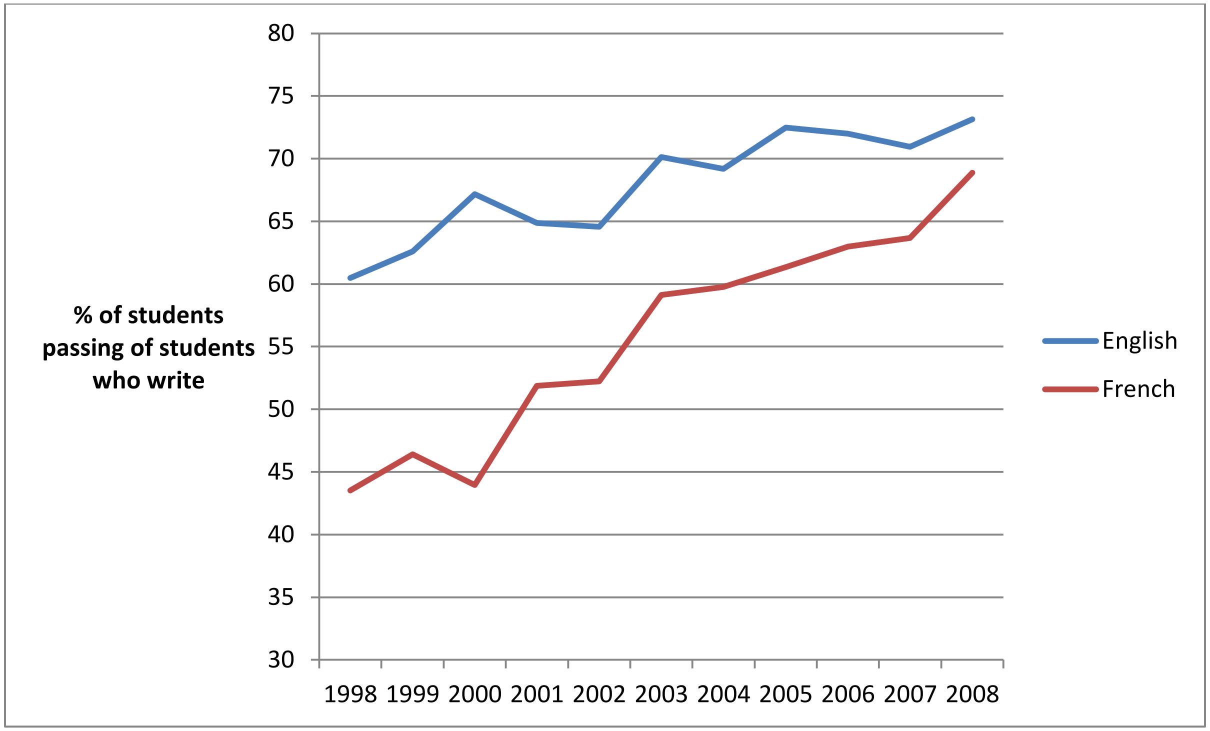


Figure 4-3 – Percentage of Students Passing Grade 3 Math Test



Appendix Table 4-16 – Grade 3 Reading, Score 2 or Above, Basic

	(1)	(2)	(3)	(4)
Female	0.0299***	0.0299***	0.0299***	0.0299***
	(0.000924)	(0.000924)	(0.000926)	(0.000925)
ESL/ELD	-0.102***	-0.101***	-0.101***	-0.101***
	(0.00930)	(0.00935)	(0.00938)	(0.00936)
Special needs	-0.209***	-0.208***	-0.208***	-0.208***
	(0.00976)	(0.00975)	(0.00975)	(0.00975)
FSA New Imm. %	0.000383	0.000415	0.000428	0.000429
	(0.000529)	(0.000524)	(0.000523)	(0.000523)
FSA % with BA	0.00119***	0.00119***	0.00119***	0.00119***
	(0.000155)	(0.000153)	(0.000153)	(0.000153)
FSA Log Inc.	0.0706***	0.0708***	0.0710***	0.0710***
	(0.00732)	(0.00733)	(0.00734)	(0.00734)
FSA % HLFR	-0.000521***	-0.000443***	-0.000428**	-0.000444***
	(0.000153)	(0.000166)	(0.000171)	(0.000167)
FSA % vis. min	-0.000220	-0.000231	-0.000236	-0.000237
	(0.000297)	(0.000295)	(0.000294)	(0.000295)
YFDK		0.0273***	-0.00482	-0.00774
		(0.00472)	(0.00865)	(0.00753)
French Trend			0.0104***	5.369***
			(0.00266)	(1.596)
French Trend Sq.				-0.00134***
				(0.000398)
Constant	0.110	0.105	-0.824***	-239.2***
	(0.0801)	(0.0801)	(0.245)	(71.10)
Observations	1215902	1215902	1215902	1215902
Adjusted R-squared	0.046	0.047	0.047	0.047

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Appendix Table 4-17 – Grade 3 Reading, Score 2 or Above, with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.00859	-0.0101	-0.0155	-0.0175	-0.0246**	-0.0270**	-0.0276**
	(0.00814)	(0.00839)	(0.0108)	(0.0119)	(0.0122)	(0.0114)	(0.0115)
YFDK * Female	0.00158	0.00284	0.00287	0.00288	0.00271	0.00281	0.00272
	(0.00314)	(0.00275)	(0.00276)	(0.00276)	(0.00286)	(0.00278)	(0.00284)
Female	0.0298***	0.0297***	0.0297***	0.0297***	0.0297***	0.0297***	0.0297***
	(0.000950)	(0.000936)	(0.000936)	(0.000936)	(0.000937)	(0.000936)	(0.000937)
ESL/ELD	-0.101***	-0.101***	-0.101***	-0.101***	-0.101***	-0.101***	-0.101***
	(0.00936)	(0.00947)	(0.00947)	(0.00948)	(0.00949)	(0.00949)	(0.00949)
Special needs	-0.208***	-0.210***	-0.210***	-0.210***	-0.210***	-0.210***	-0.210***
	(0.00975)	(0.00995)	(0.00995)	(0.00995)	(0.00995)	(0.00995)	(0.00995)
FSA New Imm. %	0.000429	0.000429	0.000433	0.000424	0.000449	0.000423	0.000442
	(0.000523)	(0.000523)	(0.000522)	(0.000525)	(0.000524)	(0.000526)	(0.000525)
FSA % with BA	0.00119***	0.00119***	0.00119***	0.00119***	0.00117***	0.00120***	0.00118***
	(0.000153)	(0.000153)	(0.000154)	(0.000154)	(0.000154)	(0.000154)	(0.000155)
FSA Log Inc.	0.0710***	0.0710***	0.0709***	0.0708***	0.0726***	0.0712***	0.0723***
	(0.00734)	(0.00733)	(0.00733)	(0.00731)	(0.00748)	(0.00730)	(0.00748)
FSA % HLFR	-0.000444***	-0.000447***	-0.000526***	-0.000532***	-0.000523***	-0.000535***	-0.000527***
	(0.000167)	(0.000167)	(0.000150)	(0.000151)	(0.000152)	(0.000150)	(0.000151)
FSA % vis. min	-0.000237	-0.000237	-0.000239	-0.000238	-0.000246	-0.000237	-0.000243
	(0.000295)	(0.000295)	(0.000294)	(0.000295)	(0.000295)	(0.000295)	(0.000295)
French Trend	5.363***	5.758***	5.846***	5.852***	5.761***	5.581***	5.638***
	(1.590)	(1.559)	(1.550)	(1.545)	(1.556)	(1.619)	(1.607)
French Trend Sq.	-0.00134***	-0.00143***	-0.00146***	-0.00146***	-0.00144***	-0.00139***	-0.00140***
	(0.000397)	(0.000389)	(0.000386)	(0.000385)	(0.000388)	(0.000404)	(0.000401)
YFDK * Special Needs		0.0254**	0.0249**	0.0250**	0.0245**	0.0249**	0.0245**
		(0.0109)	(0.0109)	(0.0109)	(0.0107)	(0.0109)	(0.0108)
YFDK * ESL/ELD		-0.00234	-0.00131	-0.00116	-0.00340	-0.00338	-0.00406
		(0.0145)	(0.0151)	(0.0152)	(0.0143)	(0.0147)	(0.0143)

YFDK * FSA % HLFR			0.000339 (0.000233)	0.000371 (0.000248)	0.000326 (0.000226)	0.000354* (0.000203)	0.000325 (0.000205)
YFDK * FSA % New Imm				0.000154 (0.000150)	0.000194 (0.000167)	0.000457*** (0.000150)	0.000344** (0.000170)
YFDK * FSA Low Inc					0.0159*** (0.00519)		0.0117** (0.00555)
YFDK * FSA % Med Inc					0.00728*** (0.00270)		0.00523* (0.00278)
YFDK * FSA % Low Ed						0.0159*** (0.00575)	0.00867* (0.00504)
YFDK * FSA % Med Ed						0.00614 (0.00497)	0.00279 (0.00336)
Constant	-239.0*** (70.83)	-256.5*** (69.44)	-260.4*** (69.03)	-260.7*** (68.84)	-256.6*** (69.30)	-248.7*** (72.09)	-251.2*** (71.55)
Observations	1215902	1215902	1215902	1215902	1215902	1215902	1215902
Adjusted R-squared	0.047	0.047	0.047	0.047	0.047	0.047	0.047

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Appendix Table 4-18 – Grade 3 Writing, Score 2 or Above, Basic

	(1)	(2)	(3)	(4)
Female	0.0117***	0.0117***	0.0117***	0.0117***
	(0.000684)	(0.000684)	(0.000685)	(0.000683)
ESL/ELD	-0.0127***	-0.0124***	-0.0123***	-0.0123***
	(0.00233)	(0.00229)	(0.00228)	(0.00229)
Special needs	-0.0467***	-0.0467***	-0.0467***	-0.0467***
	(0.00313)	(0.00314)	(0.00314)	(0.00314)
FSA New Imm. %	0.000161	0.000176	0.000181	0.000182
	(0.000128)	(0.000126)	(0.000125)	(0.000125)
FSA % with BA	0.0000862**	0.0000860**	0.0000856**	0.0000856**
	(0.0000371)	(0.0000361)	(0.0000359)	(0.0000360)
FSA Log Inc.	0.0182***	0.0183***	0.0184***	0.0184***
	(0.00193)	(0.00196)	(0.00197)	(0.00196)
FSA % HLFR	-0.000144**	-0.000107*	-0.000101*	-0.000114*
	(0.0000611)	(0.0000567)	(0.0000578)	(0.0000586)
FSA % vis. min	-0.0000221	-0.0000276	-0.0000295	-0.0000300
	(0.0000686)	(0.0000673)	(0.0000670)	(0.0000671)
YFDK		0.0131***	0.000313	-0.00206
		(0.00313)	(0.00560)	(0.00335)
French Trend			0.00417**	4.374***
			(0.00166)	(0.427)
French Trend Sq.				-0.00109***
				(0.000106)
Constant	0.791***	0.789***	0.422***	-191.7***
	(0.0210)	(0.0213)	(0.143)	(18.83)
Observations	1238474	1238474	1238474	1238474
Adjusted R-squared	0.018	0.018	0.018	0.019

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Appendix Table 4-19 – Grade 3 Writing, Score 2 or Above, with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	-0.00156	-0.00144	-0.00294	-0.00109	-0.00372	-0.00638	-0.00696
	(0.00377)	(0.00388)	(0.00480)	(0.00482)	(0.00525)	(0.00509)	(0.00524)
YFDK * Female	-0.000936	-0.000702	-0.000692	-0.000702	-0.000751	-0.000741	-0.000751
	(0.00154)	(0.00139)	(0.00140)	(0.00140)	(0.00141)	(0.00141)	(0.00141)
Female	0.0117***	0.0117***	0.0117***	0.0117***	0.0117***	0.0117***	0.0117***
	(0.000712)	(0.000708)	(0.000708)	(0.000708)	(0.000709)	(0.000708)	(0.000708)
ESL/ELD	-0.0123***	-0.0121***	-0.0122***	-0.0122***	-0.0122***	-0.0122***	-0.0122***
	(0.00229)	(0.00226)	(0.00226)	(0.00226)	(0.00226)	(0.00226)	(0.00226)
Special needs	-0.0467***	-0.0471***	-0.0471***	-0.0471***	-0.0471***	-0.0471***	-0.0471***
	(0.00314)	(0.00331)	(0.00331)	(0.00331)	(0.00331)	(0.00331)	(0.00331)
FSA New Imm. %	0.000182	0.000181	0.000182	0.000190	0.000196	0.000190	0.000191
	(0.000125)	(0.000125)	(0.000125)	(0.000124)	(0.000124)	(0.000125)	(0.000124)
FSA % with BA	0.0000857**	0.0000856**	0.0000858**	0.0000874**	0.0000834**	0.0000924**	0.0000913**
	(0.0000360)	(0.0000361)	(0.0000362)	(0.0000363)	(0.0000362)	(0.0000365)	(0.0000365)
FSA Log Inc.	0.0184***	0.0183***	0.0183***	0.0184***	0.0188***	0.0185***	0.0186***
	(0.00196)	(0.00196)	(0.00196)	(0.00199)	(0.00209)	(0.00199)	(0.00205)
FSA % HLFR	-0.000114*	-0.000116*	-0.000138**	-0.000133**	-0.000130**	-0.000137**	-0.000135**
	(0.0000586)	(0.0000588)	(0.0000648)	(0.0000642)	(0.0000640)	(0.0000643)	(0.0000643)
FSA % vis. Min	-0.0000300	-0.0000296	-0.0000303	-0.0000310	-0.0000327	-0.0000309	-0.0000312
	(0.0000671)	(0.0000671)	(0.0000670)	(0.0000666)	(0.0000665)	(0.0000665)	(0.0000664)
French Trend	4.377***	4.536***	4.561***	4.552***	4.525***	4.419***	4.424***
	(0.425)	(0.407)	(0.420)	(0.428)	(0.439)	(0.460)	(0.457)
French Trend Sq.	-0.00109***	-0.00113***	-0.00114***	-0.00114***	-0.00113***	-0.00110***	-0.00110***
	(0.000106)	(0.000101)	(0.000105)	(0.000107)	(0.000109)	(0.000115)	(0.000114)
YFDK * Special Needs		0.00550	0.00538	0.00533	0.00515	0.00522	0.00518
		(0.00521)	(0.00524)	(0.00523)	(0.00512)	(0.00516)	(0.00514)
YFDK * ESL/ELD		-0.00949*	-0.00920*	-0.00935*	-0.00985**	-0.0102**	-0.0102**
		(0.00504)	(0.00517)	(0.00499)	(0.00483)	(0.00468)	(0.00471)

YFDK * FSA % HLFR			0.0000962	0.0000679	0.0000672	0.0000717	0.0000770
			(0.0000863)	(0.0000903)	(0.0000902)	(0.0000731)	(0.0000779)
YFDK * FSA % New Imm				-0.000139*	-0.000125	0.0000196	0.0000119
				(0.0000789)	(0.0000894)	(0.0000895)	(0.0000891)
YFDK * FSA Low Inc					0.00414**		0.000934
					(0.00207)		(0.00133)
YFDK * FSA % Med Inc					0.00326***		0.00145
					(0.00118)		(0.00105)
YFDK * FSA % Low Ed						0.00741***	0.00681***
						(0.00263)	(0.00202)
YFDK * FSA % Med Ed						0.00504***	0.00464***
						(0.00184)	(0.00169)
Constant	-191.8***	-198.8***	-199.9***	-199.5***	-198.4***	-193.7***	-193.9***
	(18.73)	(17.92)	(18.50)	(18.88)	(19.33)	(20.27)	(20.15)
Observations	1238474	1238474	1238474	1238474	1238474	1238474	1238474
Adjusted R-squared	0.019	0.019	0.019	0.019	0.019	0.019	0.019

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Appendix Table 4-20 – Grade 3 Math, Score 2 or Above, Basic

	(1)	(2)	(3)	(4)
Female	-0.000480	-0.000475	-0.000471	-0.000478
	(0.000563)	(0.000563)	(0.000563)	(0.000563)
ESL/ELD	-0.0349***	-0.0345***	-0.0344***	-0.0344***
	(0.00360)	(0.00353)	(0.00351)	(0.00352)
Special needs	-0.105***	-0.105***	-0.105***	-0.105***
	(0.00528)	(0.00527)	(0.00526)	(0.00527)
FSA New Imm. %	0.000360	0.000383	0.000388	0.000388
	(0.000403)	(0.000398)	(0.000397)	(0.000398)
FSA % with BA	0.000513***	0.000513***	0.000513***	0.000513***
	(0.000119)	(0.000119)	(0.000119)	(0.000119)
FSA Log Inc.	0.0461***	0.0463***	0.0463***	0.0463***
	(0.00718)	(0.00723)	(0.00724)	(0.00723)
FSA % HLFR	-0.000408***	-0.000351***	-0.000346***	-0.000357***
	(0.000116)	(0.000112)	(0.000112)	(0.000113)
FSA % vis. min	-0.000228	-0.000236	-0.000238	-0.000239
	(0.000208)	(0.000206)	(0.000206)	(0.000206)
YFDK		0.0204***	0.00784	0.00581
		(0.00329)	(0.00735)	(0.00530)
French Trend			0.00409*	3.830***
			(0.00206)	(1.084)
French Trend Sq.				-0.000955***
				(0.000270)
Constant	0.462***	0.458***	0.105	-164.6***
	(0.0768)	(0.0774)	(0.179)	(46.71)
Observations	1274088	1274088	1274088	1274088
Adjusted R-squared	0.029	0.030	0.030	0.030

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

Appendix Table 4-21 – Grade 3 Math, Score 2 or Above, with Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
YFDK	0.00655	0.00629	0.00435	0.00548	0.00354	0.000237	0.00118
	(0.00539)	(0.00569)	(0.00668)	(0.00711)	(0.00746)	(0.00707)	(0.00666)
YFDK * Female	-0.00139	-0.00113	-0.00111	-0.00112	-0.00119	-0.00116	-0.00118
	(0.00139)	(0.00138)	(0.00138)	(0.00138)	(0.00136)	(0.00137)	(0.00135)
Female	-0.000413	-0.000426	-0.000426	-0.000425	-0.000424	-0.000426	-0.000425
	(0.000566)	(0.000568)	(0.000568)	(0.000568)	(0.000567)	(0.000568)	(0.000567)
ESL/ELD	-0.0344***	-0.0344***	-0.0344***	-0.0344***	-0.0344***	-0.0344***	-0.0344***
	(0.00352)	(0.00354)	(0.00355)	(0.00355)	(0.00355)	(0.00355)	(0.00355)
Special needs	-0.105***	-0.105***	-0.105***	-0.105***	-0.105***	-0.105***	-0.105***
	(0.00527)	(0.00546)	(0.00546)	(0.00546)	(0.00546)	(0.00546)	(0.00546)
FSA New Imm. %	0.000388	0.000388	0.000390	0.000394	0.000405	0.000393	0.000401
	(0.000398)	(0.000398)	(0.000397)	(0.000398)	(0.000396)	(0.000399)	(0.000397)
FSA % with BA	0.000513***	0.000513***	0.000513***	0.000514***	0.000506***	0.000519***	0.000513***
	(0.000119)	(0.000120)	(0.000120)	(0.000120)	(0.000122)	(0.000119)	(0.000121)
FSA Log Inc.	0.0463***	0.0463***	0.0463***	0.0464***	0.0471***	0.0465***	0.0469***
	(0.00723)	(0.00723)	(0.00724)	(0.00724)	(0.00750)	(0.00727)	(0.00749)
FSA % HLFR	-0.000357***	-0.000358***	-0.000386***	-0.000384***	-0.000381***	-0.000386***	-0.000384***
	(0.000113)	(0.000113)	(0.000130)	(0.000130)	(0.000130)	(0.000129)	(0.000130)
FSA % vis. min	-0.000239	-0.000238	-0.000239	-0.000240	-0.000243	-0.000239	-0.000241
	(0.000206)	(0.000206)	(0.000206)	(0.000205)	(0.000205)	(0.000206)	(0.000205)
French Trend	3.834***	3.929***	3.962***	3.958***	3.915***	3.809***	3.826***
	(1.084)	(1.057)	(1.065)	(1.073)	(1.075)	(1.111)	(1.111)
French Trend Sq.	-0.000956***	-0.000980***	-0.000988***	-0.000987***	-0.000976***	-0.000950***	-0.000954***
	(0.000270)	(0.000264)	(0.000266)	(0.000267)	(0.000268)	(0.000277)	(0.000277)
YFDK * Special Needs		0.00514	0.00499	0.00497	0.00476	0.00489	0.00481
		(0.00706)	(0.00714)	(0.00714)	(0.00701)	(0.00711)	(0.00703)
YFDK * ESL/ELD		-0.00200	-0.00163	-0.00172	-0.00282	-0.00290	-0.00325
		(0.00885)	(0.00903)	(0.00892)	(0.00801)	(0.00846)	(0.00795)

YFDK * FSA % HLFR			0.000125	0.000108	0.0000700	0.0000998	0.0000723
			(0.000114)	(0.000119)	(0.000104)	(0.0000985)	(0.0000951)
YFDK * FSA % New Imm				-0.0000844	-0.0000721	0.0000822	0.0000394
				(0.000114)	(0.000122)	(0.000108)	(0.000129)
YFDK * FSA Low Inc					0.00706*		0.00412
					(0.00418)		(0.00496)
YFDK * FSA % Med Inc					0.00106		-0.000459
					(0.00314)		(0.00331)
YFDK * FSA % Low Ed						0.00865***	0.00614*
						(0.00282)	(0.00318)
YFDK * FSA % Med Ed						0.00353**	0.00266
						(0.00166)	(0.00207)
Constant	-164.8***	-168.9***	-170.3***	-170.1***	-168.3***	-163.7***	-164.5***
	(46.72)	(45.54)	(45.90)	(46.22)	(46.34)	(47.88)	(47.85)
Observations	1274088	1274088	1274088	1274088	1274088	1274088	1274088
Adjusted R-squared	0.030	0.030	0.030	0.030	0.030	0.030	0.030

Robust standard errors are in parentheses (clustered on board number).
* p<.10, ** p<.05, *** p<.01

5) Conclusion

In the three essays of this thesis, I have attempted to measure the impacts of government education policies on student outcomes. The first two essays focus on the issue of school choice. My data come from the unique context of Ontario, where multiple public school boards (most importantly the public and Catholic boards) compete for students and funding dollars.

In the first paper, I examine the issue of whether choice at the high school level leads to an increased likelihood of students applying for university. I contribute to the literature by adapting a methodology to take advantage of the fact that students are relatively free to choose high schools within their school board, but are unable to cross a school board boundary. This discontinuity allows me to compare otherwise similar neighbourhoods on opposite sides of a school board boundary, by matching the neighbourhoods along a series of demographic characteristics of their inhabitants.

I find that students from neighbourhoods in which there is more school choice are more likely to apply to universities. However, this effect appears to be a result of competition between public and Catholic school boards, rather than between schools within the same school board. That is, I observe a positive impact of an increase in accessible *Catholic* schools on the university application rate of public school students and vice versa.

In the second paper, I study which students take advantage of the increased choice and what this means for the distribution of students within schools. In the U.S. context, other papers have shown that it is the brightest and most motivated students who are most likely to make use of the increased choice provided by new programs such as vouchers or open enrolment. I use a new and unique dataset in which I observe Ontario student test scores in grade 6 and again in grade 9. This allows me to identify which students are "opting out" of their assigned local schools.

As predicted by a theoretical model, I find that it is the brightest students who are most likely to benefit from the increased choice by opting out of their assigned schools. This effect increases the availability of school choice. Furthermore, students who opt out are most likely to attend an alternative school with a stronger cohort of peers. This means that, with more choice, the make-up of students within schools becomes more homogeneous, while the differences across schools increase. While I do not measure peer effects, to the extent that such effects are important, school choice has the potential to be detrimental to weaker students who stay behind at weaker schools.

The third paper is a departure from the question of school choice. Instead, I and my two coauthors, examine the impacts of a switch from half-day to full-day kindergarten on students in French-language school boards of Ontario. We use a difference-in-difference methodology with students in the English-language boards acting as the control group. This study contributes to the literature in several important ways. First of all, using the EQAO test score database allows us to examine all students across Ontario, rather than focus on only a small sample of students or schools. Secondly, we examine a longer-run outcome (grade 3 and 6 test scores) than is standard in the literature.

We do not find any overall effect of the switch to full-day kindergarten on test scores. However, there is some evidence of heterogeneous treatment effects: we observe small positive impacts on students in the lower range of the test score distribution living in low-income or low-education neighbourhoods.