Preliminary Draft

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The interpretation of elementary school test scores in Ontario:

A statistical analysis from the years 1998-99, 1999-00, 2000-01 and 2001-02

David Johnson
Department of Economics
Wilfrid Laurier University
Waterloo Ontario N2L 3C5
telephone: 519-884-1970 ext 2540
email: djohnson@wlu.ca

Abstract

The four years of EQAO assessments at Ontario elementary schools create a measure of student achievement at each school. This measure, the percentage of students in Grade 3 or Grade 6 that show mastery of the Ontario curriculum at their grade level is used as a measure of school success. The social and economic characteristics of each school are measured by linking student postal code data to the 1996 census. These social and economic characteristics explain a great deal BUT NOT ALL of the variation in school achievement results. There is substantial variation in student achievement between schools with similar social and economic characteristics. This is an important finding. This variation remains to be explained Many different social and economic variables are statistically related to school achievement results. They include income, parental education, language, immigration history, aboriginal status, unemployment, mobility and housing type.

Acknowledgments:

The presentation at this conference is part of a larger project undertaken by the C.D. Howe Institute and funded by the Donner Canadian Foundation. Some funding was provided by the Social Sciences and Humanities Research Council of Canada through the Research Office at Wilfrid Laurier University. The list of people who have contributed is longer than usual, but appropriate given the magnitude of this project. Tommy Wu has been a very helpful research assistant. Jennifer Dickson, a former student in the Master in Arts, Business Economics at Wilfrid Laurier and I worked together on a pilot study of testing using the schools in the Waterloo Regional District School Board. That work was the genesis of this project. Statistical assistance and advice was provided at various times by Mike Veall, Terry Levesque, Tom Crossley and the Statistical Consulting Service at the University of Waterloo. Howard Kim at the Ministry of Education and Kirsten McKnight at the Education Quality Accountability Office helped enormously in understanding and sorting the school files. Finally the staff at the Tri-University Data Centre at the University of Guelph was invaluable in helping to handle the census files. The errors in the analysis remain my responsibility.   This research into school testing touches many emotional nerves in Ontario. I am very grateful for the patience shown by a variety of people. We all gingerly stepped through   the minefield and worked together to try to understand the educational process better. There are no simple answers. I do not pretend to have the complete story, just part of the picture.

1 An introduction to the interpretation of elementary school test results in Ontario

Standardized testing, a common assessment of student performance across a large number of schools in a jurisdiction is controversial. Does it improve educational outcomes? Is it fair? Is it useful? In 1996 Ontario joined a large number of other jurisdictions in North American in implementing a standardized assessment of student performance at the elementary level. Parents, teachers, educational administrators, politicians hold a variety of views on the effectiveness of the process and its usefulness. This paper presents a statistical analysis of standardized test results from the academic years 1998-99, 1999-00, 2000-01 and 2001-2 . The paper is an analysis of results reported by grade at a school. There are up to 24 results on each elementary school in the province, results from the four years in two grades in three areas: reading, writing and mathematics. There are about 3500 elementary schools in the available data. This is an enormous mass of numbers. What has been learned to this point? I present below, as a series of questions and answers, the results of this research to date. This serves as a summary of today's presentation.

Question One: Is it true that school assessment results show an improvement over time in the learning outcomes of elementary school students in Ontario?

It will frustrate readers to discover that this very important question cannot be answered directly using the data in this project. Why not? The aggregate achievement level on any assessment (test) depends on (1) the ability of the students in a given year to actually master the material (2) the consistency of the assessment instrument over time across years and (3) the grading of the assessment material. A higher score could be the result of better learning by students, an easier test or more relaxed grading of the same test. The data we have simply cannot distinguish among these three possibilities.

Question Two: **I am frustrated! Can't you say anything about whether Ontario students have actually improved over the last four years of assessments?**

I can state that, <u>if you believe the assessments were correctly designed and were equally difficult in all years and the assessments were graded consistently</u>, then student achievement levels have increased since the 1998-99 assessment.   In this sense, achievement levels and learning outcomes of Ontario students have improved. These improvements are statistically significant.

Question Three: **I am still a little bit frustrated. Does all the statistical evidence I am about to read tell us anything about whether the assessment process was correctly designed and has been consistent over time?**

There is no direct evidence in this study on this question. There are shreds of indirect evidence. The indirect evidence is, in my interpretation, in favour of the view that the assessments were correctly designed.   The fact that achievement results have risen slowly over time is indirect evidence that the observed increase in results actually reflects better performance by students. They rise slowly, as would be expected in a large and complex organization trying to effect improvement. There is some evidence that the exemption process is fairly consistent across boards. This is indirect, albeit weak evidence, of consistency in the administration of the assessments. The EQAO reports a substantial effort is put into pre-testing and design of the assessments. It is very encouraging that the EQAO is set up as an independent entity in terms of design and administration. Governance theory tells us that is an important design feature of the EQAO. We know the EQAO makes a huge effort to grade the assessments in a consistent way over time. But in the end, the educational researchers, not an economist, has to answer the question: Is the assessment instrument valid> Is the assessment instrument consistent over time? I do not have the expertise to answer these questions.

Question Four: Do the answers to Questions One, Two and Three mean that the assessment process is useless?

Absolutely not! The assessment process is not useless. First, the student and the classroom teachers do get individual results. These identify strengths and weaknesses of individual students and individual schools at a much more detailed level. This is clearly desirable.

The aggregate results at the school level that are used in this study are useful for comparisons between schools. Such comparisons could be across schools on the same assessments or they could compare improvements across schools where the improvements use the same pairs or groups of assessments. I conclude that the school-level aggregate results from the EQAO process should be used to isolate differences between schools.

Question Five When I compare achievement results in different schools in my community, I notice that the best achievement results come from schools where parents are well-to-do and well educated. Is it possible

to measure the family background of students at elementary schools so that we can make a fairer comparison?

The answer to this question is a resounding YES! The Ministry of Education collected postal codes of all students at Ontario elementary schools in the years 1999-00, 2000-01 and 2001-02. By linking the knowledge the location of the students' homes through their postal code to very small geographic units of the census, a very complete and accurate picture can be drawn of the family backgrounds of students at any elementary school. This can be carried out at low cost.

Question Six: I have read that good assessment results only occur at schools where the students come from affluent, well-educated families. Is that true?

No this is not true. Because the answer to Question Five is YES, we can also answer Question Six. While it is certainly true that there is a strong relationship between a variety of social and economic variables and school achievement levels, it is NOT TRUE that good achievement results ONLY occur at schools where there are well-educated affluent parents. Instead there are schools with less-affluent and less well-educated parents where achievement results are high and there are schools with affluent well-educated parents where achievement results are not that high. The key part of the response to Question Six is that good results do not ONLY come at high-income schools. They come from other types of schools as well.

This has important policy implications. It is important to find out what makes two schools with the same social and economic characteristics perform better on assessments. There is a lot of unexplained variation across performance of similar schools. This variation persists year-after-year.[1] Family background is not the only determinant of school achievement.

Question Seven: What factors play a role in predicting schools with high achievement levels?

It is true that higher income levels and more educated parents raise achievement levels. Other variables matter as well. These include language variables, measures of unemployment, measures of mobility, measures of housing status, measures of immigration, aboriginal status and measures of lone parenthood. All of these variables play a statistically significant role in relating to high achievement in school assessments.

Question Eight: Are there more questions to ask about the interpretation of elementary school test results?

Yes. This presentation and paper are part of a larger project to understand a variety of aspects of the interpretation of elementary school test results in Ontario.

The remainder of this paper explains how a long and careful look at the assessment data leads you to the questions and answers above. This presentation is part of a larger project. I continue the analysis with drafts of three chapters from a forthcoming book that describes and analyses the

[1] It is important to look at a number of years of results in making any school comparisons. There is a lot of variation from year-to-year across elementary classes at the same school.

elementary school testing process in Ontario. The book is to be published by the C.D. Howe Institute. The research is sponsored by the Donner Canadian Foundation. Because the presentation is part of the larger project, the paper is not organized in the usual academic fashion. From this introduction I move to Chapters 3,4 and 5. Chapter 3 describes in detail the process used to create a description of your local elementary school. Chapter 4 presents estimates of the relationships between social and economic variables that describe a school and the level of academic achievement at a school. This is the heart of the contribution of this research to date. School achievement results can be placed in the context of their school community. Chapter 5 is a brief discussion of the exemption process. This provides indirect evidence on the consistency of the assessment process. This introduction serves as the conclusion to the paper as well. References and a detailed data appendix remain to be written.

Chapter 3 : Describing your elementary school

3.1 Introduction

The biggest problem in the analysis of the results of EQAO testing is placing any school achievement results in context. Context could and does mean the year in which the assessment was written and graded. Although all efforts are made to create tests and grade tests so that year-to-year comparisons are possible, the tests could vary in difficulty and grading standards over time. Although this is an important issue in making year-over-year comparisons in Ontario as a whole, this is not the major concern in making comparisons across schools or boards.[2] For this purpose, the context of the school means a description of the social and economic background of the community from which this school draws its students. It is absolutely clear to all the participants and all analysts of school achievement results that the social and economic background of students plays an enormous role in the determination of the success of students. I fully expected to find that the social and economic background of students are the most important determinants of success in academic testing. Does this mean that province-wide testing is useless? As we noted in Chapter 2, some participants in the process have made and do make such arguments. However, the purpose of this research is to ask an important question: Is there is still systematic and interesting variation by school or board <u>after the variation in results that is explained by variation in the background of students</u>,? A second way to phrase this question: Does variation in the social and economic background of students explain all or

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[2]This issue is considered at length in the next chapter.

virtually the variation in achievement results across schools? The task of this chapter is to explain how the variables that measure the family background of students at a particular school are created. Some data are then presented to give the reader a sense of how much variation there is across schools in Ontario in these measures. Other researchers are making the effort to measure the social and economic background of students at Ontario schools. There is a brief discussion toward the end of the chapter of the Education Quality Indicators Program (acronym EQUIP), a parallel effort to describe variation across schools that is currently underway at the EQAO. The process of creating the data to describe Ontario elementary schools involves a number of steps. The process is described in some detail so that the other users of the results generated in this study know both the strengths and weaknesses of the data set created.

3.2 The first step: school enrolments and the postal codes of students

There is no access to data that describes the social and economics characteristics of individual students at a school. Such data is not collected. It would be an intrusion on privacy if it were collected.[3] Beginning in the 1999-00 academic year, the Ministry of Education of Ontario collected and created a file with the number of each gender of students at each postal code at elementary schools in the province. This process was repeated in the 2000-01 and 2001-02 academic years. There are now three lists containing postal codes and the number of students attending a school from that postal

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[3]In the Toronto Star, May 2003, Marita Voll complains that surveys associated with school testing are “seeking to extract as much information as possible about Jimmy”.

code.[4] This data must be checked before its use.

I summed, over the postal codes at a school, the number of students. This is the estimate of total enrolment at each school in the Ministry postal code file. This check revealed small errors in the data. I discuss these errors not as a criticism of the data but as a warning to other users. This is a very large and complex data set. First, in the first two academic years of the postal code data, there were some exact duplicates, observations identical in every way. These duplicates were removed. There were some postal codes with a very large number of students. For example, one postal code at a school had 2000 girls and no boys, a very unlikely event. Checking by Ministry staff revealed these codes were typographical errors and these are now corrected. [5] Finally, only in the first two academic years, some observations at schools were "complex duplicates." A "complex duplicate" is an observation at the same school and the same same postal code but with two different observations of enrolments. The usual "complex duplicate" occurred when the first observation listed the boy enrolment, the girl enrolment and the total enrolment while the second "complex duplicate" observation contained the girl enrolment, the boy enrolment and the total enrolment. Thus the boy and girl enrolments were repeated and reserved while the total remained the same. I dropped one of these duplicate observations at random. The Ministry files improve significantly over time. In the 1999 public school file, exact duplicates are 4 percent of the data and complex duplicates are 0.2 percent of the data. In the 2001 file there are neither exact nor complex duplicates. The files differ slightly in

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[4] The Education Quality Indicators Program (EQUIP) also makes use of postal code data. I briefly describe the EQUIP program later in this chapter and compare the variables created in the EQUIP data set to the data described below. The EQUIP data are not yet in public release.

[5] I am grateful to Howard Kim at the Ministry of Education for his help.

other ways over the three years.

Tables 3-1 and 3-2 present some information about the data from the postal code files. Table 3-1 contains the number of schools, the smallest enrolment, the largest enrolment and the average enrolment in each academic year. Public boards and Catholic boards are presented separately. Look at the first row that refers to each academic year. Coverage increases substantially from the 1999-00 academic year to the 2000-01 academic year for both types of boards. Coverage rises again, but not as much, from the 2000-01 to the 2001-02 academic year. Table 3-2 compares the coverage in the postal code file in the 2000-01 academic year to the total number of schools and students as reported by the Ministry for that academic year.[6] About 95 percent of both types of schools are covered by postal code information. In the public boards, these schools account for 95 percent of students, in the separate boards, these account for 92 percent of students. The remaining rows in Tables 3-1 and 3-2 refer to complications around the linking of the postal code data to the census data from the 1996 and 2001 census.[7]

3.3 Links to the smallest geographic units of the 1996 and 2001 census

The census asks a variety of questions of Canadians. Some questions are posed to all Canadians and a more detailed set of questions are presented to a 20 percent sample of Canadians.

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[6] The Ministry website posts 2000-2001 as the latest year of data.

[7] In the results to this point, only the 1996 census is used. The 2001 census is not fully released of the DA level. Final release is scheduled for June 17, 2003.

The latter group receives the “long form.”[8] The census then reports answers to these questions summarized for a variety of geographic units. Large geographic units, provinces, municipalities and counties are not useful in the analysis of the characteristics of families with children at a particular school. Provinces and municipalities are the census units we normally use and think about. Fortunately for this project, the census results are also presented for very small geographic units. These units are known as Enumeration Areas (EAs) in the 1996 census and Dissemination Areas (DAs) in the 2001 census. In each case between 40 and 2000 persons reside in an EA or a DA. The average unit contains about 700 persons. Although we do not know the characteristics of individual students at a school in a given year, if we know the student’s postal code we know what EA or DA that student lives in. We can know the average characteristics of a student’s family. There are some slight differences between the 1996 and 2001 census variables, partly due to the questions asked and partly due to the ongoing release of the 2001 census over the spring of 2003 as this research is being conducted. There is also a difference in the link between the knowledge of the postal code and the smallest geographic units in the 1996 and 2001 censuses.

For the users of the 1996 census, Statistics Canada provides a postal code conversion file with weights. About 90% of the weights are unity. This means that all of the persons at that postal code live in that EA. When a postal code covers a large geographic area, then only a proportion of persons living at that code live in a specific EA. This occurs mainly in rural areas. The weights provided by

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[8] A description of the census data and links to the forms are found in two volumes: 1996 Census Handbook Reference, Statistics Canada Catalogue No. 92-352-XPE and 2001 Census Handbook, Statistics Canada Catalogue No. 92-379-XIE. Both can be found at the Statistics Canada web site.

Statistics Canada measure the proportion of people in that postal code who live in that EA. For each postal code with multiple EAs, we can and do aggregate the EAs using the weights into an "artificial" EA with the weighted average characteristics of group of Eas linked to that postal code. This exact exercise is not possible using the 2001 census.

Statistics Canada also provides a postal code conversion file that identifies the DA in the 2001 census with a specific postal code in 2001. In 80 percent of postal codes, one postal code is linked to one DA. In the other 20 percent of postal codes, there are links to several DAs. However the 2001 conversion file has no weights. Statistics Canada does provide an SLI (Single Link Indicator) which is set equal to unity if a substantial proportion of the population of that postal code lives in that DA. As a rough and ready guide, if only one such DA is tagged, then I simply assume all of the population from that code lives in that DA. If two such DAs are tagged, then I placed a weight of 0.5 on each DA for that code. If 3 such DAs are tagged, the each receives a weight of 0.333 and so on. Any other DAs received a weight of zero (it would be very unusual that there were any other DAs) . The largest number of DAs associated with a postal code was 83 (in which there was no SLI). In that case and other similar cases, each DA received a weight of one divided by 83. In this way a unique geographic unit is created for each postal code in the 2001 census without waiting for the official 2001 postal code conversion file with the population weights One very encouraging outcome of this exercise is that the average weight on the conversion of a postal code to a DA in the 2001 census is virtually identical to the average weight on the conversion of a postal code to an EA in the 1996 census. In both censuses about 80 percent of the conversions from postal code to EA or DA are one-to-one. However there is a third complication in linking postal codes to the census units.

Not all postal codes in the school data sets exist in the postal code conversion file. In the most straightforward case, dwellings exist in the period from 1999 to 2002 (the school data) that are not part of the data from the 1996 census. It is even possible that the 2001 academic year contains students who live at postal codes that are not part of the June 2001 census data. The remainder of Table 3-1 measures the magnitude of this problem in two dimensions. There is some postal code data for virtually all schools in the Ministry data set. The exceptions are 6 Catholic schools in the 1999 data and 8 Catholic schools in the 2000 data that have postal codes at which students live and in which that there is no data from the 1996 census. One presumes these are schools built to service households in dwellings that did not exist in 1996. If all the 2001 census data were available, there are no excluded schools in either the public or Catholic categories. Only one public school is excluded from the 2000 data because of a lack of census data. We can also ask how many students are excluded from the sample because of a lack of census data on their school. A school could contain a mixture of new and old housing, housing with and without census data. Table 3-2 reveals that in the 2000 academic year, postal code data and the 1996 census reveals the average characteristics of 90 percent of public school students and 86 percent of Catholic school students. The 2001 census will raise those values to 94 and 92 percent respectively. How do we combine the information in the census data with the data in the postal code file?

For every year where some postal code data exist, it is possible to create school-based measures based on the responses to the census. Each postal code-EA (or postal code-DA combination in the 2001 census) combination is weighted by the enrolment at that combination relative to the total enrolment at that school (the enrolment is determined by the sum of all the students living at census-linked postal codes). For example, a school could have only two EAs, one with 60 percent of the school's enrolment and one with 40 percent of the school's enrolment. Suppose at the first EA, 100 percent of family units are lone parents and at the second EA, none of the families are lone parents. The percentage of lone parents in this school community is 60 percent: (0.6 x 100) + (0.4 x 0). This measure can be constructed for each year of postal codes and for each year of the census. A school could have up to 6 measures of a given census characteristic or only one measure of this characteristic depending on the availability of the postal code data. To create the school-based measures, the different census-based measures from the different academic years and, where possible, the two censuses are averaged together. This makes sense. The school observations on achievement use Grade 3 and Grade 6 students drawn from a number of academic years and from the entire period between the two censuses. The units of measurement in the two censuses are the same.[9] What measures of school context are constructed?

3.4 The measures of school characteristics from the census

Immigration and language variables

Immigration and language variables are frequently used as context variables for schools. Indeed in some years the EQAO achievement results are presented for ESL (English as a Second

[9] The one exception is the measure of family income. Here the 1996 census uses 1996 dollars and the 2001 census will use 2001 dollars. Thus the second measure is deflated using the Consumer Price Index.

Language) and non-ESL students. The census data allow four variables of this type to be created at the school level. The first two variables are the percent of the population in the school population that is drawn from recent immigrants (excluding immigrants from the United Kingdom and the United States). One variable is the percentage of the school community that immigrated to Canada within the last year. The second variable is the percentage of the school community that immigrated to Canada in the last 5 years. These two variables appear in the first two rows of Table 3-3. Where possible, the first column of the table is the value of this variable when measured for all of Ontario. The average value, an average over the schools in the sample, the standard deviation across schools, and the minimum and the maximum value follow for each variable. The last column attempts to give the reader a sense of the number of schools that sit at the extremes of the distribution of each variable. A histogram gives similar information Histograms of these two immigration variable appear in Figure 3-1. You can see there are many schools where the proportion of recent immigrants is less than 5 percent. There are a few schools with a very large percentage of recent immigrants. When immigrants from all of the last five years are considered, then the immigrants are much more evenly spread throughout the school system. It is interesting that while there are many schools with only a few recent immigrants, when the immigration window is increased to 5 years, the average school in Ontario contains the same proportion of persons who have immigrated to Canada in the last 5 years as the total population. Ontario is truly a province of immigrants, slightly more so, for areas that provide the elementary school population.

There are also two variables from the census that represent language. The first variable is the percentage of the school community with either official language as its mother tongue. The second language variable asks if either official language is the main language spoken at home. For the province as a whole, 90 percent of people list an official language as the language spoken at home while 80 percent of Ontario's citizens list one of official languages as their mother tongue. In the vast majority of schools over 90 percent of students come from a language background that includes an official language. There are only 9 schools where less than 50 percent of students would speak neither English nor French as their home language. The data appear in Table 3-1. Figure 3-2 is the two histograms of the language variables.

The aboriginal variable:

The census allows a calculation of the percentage of the EA or DA that claims an aboriginal heritage in their background. All aboriginal categories in the census were included. Figure 3-3 presents two pictures of the aboriginal population in Ontario schools. The upper panel is a histogram that includes all schools. The vast majority of schools have a negligible aboriginal population. Only 80 schools in the entire province contain more than 10 percent aboriginal students. Within those 80 schools, 20 percent of the population is aboriginal. These schools range from 10 percent aboriginal to 75 percent aboriginal. Outside of those 80 schools, the lower panel of Figure 3-3 shows the distribution of the aboriginal variable in the remaining 3974 schools. The scale changes from the upper to the lower panel of Figure 3-3. The proportion of aboriginal students in Ontario is very small for the vast majority of schools..

Parental education:

Schools vary widely in the educational background of the parents that form the community that sends children to this school. There is a great deal of detailed information in the census on the educational status of persons over 15 years of age living in a census unit. The two variables presented in Table 3-3 and Figure 3-4 present the two extremes of the educational status variables. One is the percentage of persons over 15 in the school's community less than a high school education. The other is the percentage of persons in the school's community with at least some university education. Almost 48 percent of persons over 15 in Ontario have no high school diploma. However for those in areas providing elementary school children, the percentage rises to 49 percent. About 25 percent of the citizens in Ontario have at least some university education but the average percentage across the elementary school system is only 21.5 percent. The histogram in the upper portion of Figure 3-4 shows a fairly normal distribution of the percentage of adults in the community without a secondary diploma. The lower portion of the figure shoows the usual skewness in the percentage of the population with some university education. 245 schools draw from a population where more than 40 percent of persons have some university education. The maximum value of the community percentage with some university education is 70 percent. The scatter plot in Figure 3-5 shows that these two education variables do not have a simple linear relationship.[10] There is information in the extremes of the distribution of the education variables.

[10] The scatter plot uses data from schools with a total enrolment of 50 or greater. In a very small school, the percentage of the school population in one category can be highly variable. There are 94 schools with an enrolment of less than 50 and 14 schools with a total enrolment of less than 10.

Family status variables

The census reports the percent of family units within an EA or DA that are single parent families. This variable, like the other variables, is transformed to a school level variable and a histogram appears as Figure 3-6. The percent of lone parent families living in the elementary school postal codes is actually less than the provincial average. This suggests that, on average, family breakdown occurs slightly later in a family life cycle. The variable is one of the more highly highly skewed variables. There is a broad mass of schools where 15 to 30 percent of children come from single-parent situations. There are 242 schools with fewer than 10 percent lone parents and 690 schools with more than 30 percent lone parents.

Economic variables

The census is able to provide the researcher with two types of direct economic variables, unemployment rates and income measures. Figure 3-7 presents the unemployment rates for all persons over the age of 15 and for persons over the age of 15 with children in the various school communities. Descriptive statistics appear in Table 3-3. There is again some skewness - a few schools have very high unemployment rates. Unemployment rates are lower when there are children present.

There are four possible measures of income in the census: average total income for all persons with income over the age of 15; average total income for all persons aged 15 through 44 with income (the group most likely to have elementary-school children); average household income of households with two or more persons (an alternative way to include households where elementary-school students may be present); and average census family income for all census families. Table 3-4 presents some insight into these four measures.[11] Table 3-5 presents the correlation coefficients between these variables. The four variables are essentially identical. The measure used is average household income in households with two or more persons. This seems like the measure best suited to capture the presence of children in a household. Figure 3-8 is a histogram of the measure of income used. Only 63 schools have average family incomes greater than 100,000 1996 dollars and only 7 schools have average household incomes of less than 10,000 1996 dollars.

Economists view income as a type of summary statistic. It obviously measures the monetary resources available to families. It also measures education since the ability to earn a high income is strongly related to educational status. Income may also stand in for a variety of unobserved factors. One might be ability. A second could be inherited wealth that generates income. It is even possible that income could stand in for a measure of political influence. There is some anecdotal evidence that schools in higher income areas actually capture more or better resources per student than schools in lower-income areas. Because the measure is a measure of household income, it is also related to the structure of households. Figure 3-9 is a scatter plot of the percentage of lone parent families in the school community and the measure of income used. There is a fairly clear negative relationship.

Mobility and housing variables:

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[11] Income is measured in 1996 dollars. This means that the income is measured in the dollars earned and spent in 1996. Since the interest is in the comparison across schools, the units of measurement are not important.

Although the mobility and housing variables could certainly be considered economic variables, they are presented and used separately. The reason is practical. These are variables which could be measured accurately each and every year at a school without intrusion or significant additional expense. In that way, they differ from the other variables listed above. The census asks two questions about mobility in the population. The percent of a population within a school catchment population that moved within the last year and also within the last five years is measured. It would be easy to collect the percentage of new students in a school at the school level without any use of judgement and without a large commitment of system resources. The histograms for the two mobility variables appear in Figure 3-10. The descriptive statistics for the variables appear in Table 3-3. An enormous proportion of the population of Ontario moves within a 5-year period - over 40 percent. The variation across schools in this number is not that large. But only 15 percent of persons in Ontario and in school catchment populations have moved within the last year. The movement within the last year is also much more concentrated at specific schools. There are 418 schools where more than 20 percent of persons have moved in the last calendar year. There are only 16 schools where less than 5 percent of their population move within a year. As noted below, the EQUIP data set will include a very similar variable. It is not yet clear how often the variable will be updated.

The last variable in the census-based data set relates to housing used by the school community population. The variable is the percentage of occupied housing in the school community that are single detached homes. The average value of this variable in the province is 56.8 percent. The average value for the elementary school community is 65.5 percent. There is enormous variation across schools. The histogram, Figure 3-11, does not look like any other histogram presented so far. The range is wide.

Thus in this variable there is very rich and continuous variation The advantage of this variable, as with the mobility measures, is that it would be very straightforward for this data to be collected every year by a school without an intrusion on privacy or significant cost. Thus if mobility and housing status explain variation in test results as accurately as a set of more complicated measures, these variables can be put into common use.

Enrolment and gender variation

The postal code data rather than the census data allow two further measures of the characteristics of the school community. One is total enrolment at the school as measured by the postal code data. The other is the ratio of boys to total enrolment. Both variables are averages from the three years of postal code data. These variables are included in Table 3-3 and presented in Figure 3-12. These variables could be of interest for three reasons. A very small school is more likely to contain a very small Grade 3 or Grade 6. The achievement data from such a school may be suppressed more frequently because the grade level data is suppressed when there are fewer than 15 students. A small school or a very small school may have larger variation in the census variables. A school with a smaller number of students per grade may have a larger variation in assessment results from year-to-year. There may be issues related to school and grade size concerning variability of both achievement and context variables.

School size is a variable of interest in its own right. From the point-of-view of raising average achievement results, if there is a school size effect, there could an "optimum" size of school. This would be a very interesting result. The proportion of boys in a school does vary quite substantially. There is some interest in gender effects on school assessments. It is worth checking if these effects occur in the aggregated data. Both total enrolment and the proportion of boys in enrolments are variables already collected for the assessment process.

3.6 A set of interrelated variables

It is clear from the discussion above that the set of variables created to describe schools are interrelated. Two graphs of the relationship between variables have already been presented, that is, Figures 3-5 and 3-9. In this section, a closer look at the interrelationships among all the variables presented in Section 3.5 is presented. Table 3-6 presents a matrix of correlation coefficients between the 16 variables in Table 3-3. All schools are included. [12]

There are no real surprises in the relationships observed. The two immigration variables are closely but not perfectly related, with a correlation coefficient of 0.88. The two language variables are closely related and have a strong negative relationship to the immigration variable. The two education variables, as suggested by Figure 3-5, have a strong negative relationship. There are no clear relationships between the aboriginal variable and any other variable. The two unemployment variables are strongly related. There is a strong relationship between being unemployed with children and being a lone parent. The income measure is quite clearly related to both measures of education and has a weaker but still quite strong relationship to the measure of lone parenthood. Since it is a household

[12] The correlation matrix is virtually identical when schools with less than 50 students in their total enrolment (94 schools) are removed from the sample. Thus the relationships are not driven by outliers in very small schools.

income measure, that makes sense. There is less mobility when there is more detached housing but the relationship is not as strong as many other relationships in the matrix. This also makes sense, transactions costs on moves between detached housing would be much higher than on moves between other forms of housing. People in detached homes will move less. There is less detached housing when there is more lone parenting and more unemployment as well as when there is a lower average household income. There are no strong relationships between either total enrolments at schools or the ratio of boys to total enrolment.

The census provides a variety of measures of the social and economic context for each elementary school in the province where there is postal code data. This is the data that is used to place the achievement results and exemption rates in context in the next two chapters. Before doing this, I want to remind readers of the EQUIP data being put together by the EQAO. Readers of this literature should be aware that the production of this data is underway and will eventually be released.

3.7 The EQUIP data

The EQAO is fully aware of the need to place achievement results in the context of the local school environment. They are engaged in the creation of a data set describing all Ontario schools, both elementary and secondary. Only the variables created for elementary schools are discussed below. The advantage of the EQUIP data is that it includes a variety of administrative data not otherwise available to a researcher. A second advantage of the EQUIP data is the comprehensive consultation process undertaken as variables were chosen for the data set. A third advantage of the EQUIP data is that the EQAO is able to base some variables on responses to questions asked of the students being assessed as the assessments are given. This portion of the EQUIP data then directly describes the subjects of the assessments. One disadvantage of the EQUIP data is their lack of timeliness. The enrolment used and the postal codes are, as far as has been discussed in the public presentation, use the 1999-00 academic year.[13] In addition, although the EQUIP program began in ????, the data are still not in the public domain. A second disadvantage, at least from a researcher's point-of-view is that the variables that are to relate to school performance have already been chosen. We actually want to know which variables, at least from the available set of census variables, will have the closest relationship to achievement results. Table 3-7 is a list of the proposed EQUIP indicator variables that EQAO expects will be available at some point in time.

The variables are organized by EQAO into four themes: context, inputs, processes and results. The context variables are very similar to the variables constructed in the earlier part of this chapter. One difference is the inclusion of an administrative measure of exceptional students in a school, both gifted students and special needs students. To the extent that either being gifted (or being identified as gifted) correlates to census variables already created, the census variables may well proxy for such effects. A similar statement could be made about a special needs designation. The EQUIP mobility measure is the number of schools attended by students since Grade 1. This question, asked when the student participates in the Grade Three or Grade Six test, would need an obvious adjustment to be comparable across tests. This is a more precise measure of mobility than available in the census. There is an income measure constructed from postal code and census data. There is a parental education

[13] Updating may be taking place at the current time. The web site material does not address this issue.

variable also constructed from postal code data. These variables must be very similar to the variables discussed earlier.

There are a variety of measures of inputs. An attempt is made to measure inputs before a student reaches a school. There are responses to questions about pre-school attendance and a variety of measures of readiness to learn. There are some survey data on school processes, solicited from schools on processes that may prove useful, issues around school safety, attendance and class size are addressed. There will be some measures of teacher and support staff inputs: student-teacher ratios and teacher qualifications. Finally the EQUIP data will include the EQAO achievement results. When the EQUIP data are ready and released, it will be a rich and useful data set.

3.8 Conclusions

There is enormous variation in the characteristics of elementary schools in the province of Ontario. In the next two chapters, we take combinations of the variables that describe schools and measure how they relate to two specific variables in the achievement results. The next chapter, Chapter 4, looks at the percentage of students who are achieving at or above the provincial standard. Chapter 5 then looks at the evidence on variation in the exemption process. These two exercises identify what variables are important in explaining variation in school outcomes on the assessment process. When the relationships between context variables from the census and these variables have been estimated, Chapter 6 discusses the behaviour of schools which do not fit the pattern. This exercise identifies schools whose behaviour is different from that of similar schools in the province. We will pay special attention to relationships using the two variables easily collected at the school level - the mobility and housing status variables. If these variables could stand in for more precise variables that can only be collected only every 5 years, then a more timely analysis of school behaviour should be possible. This would be very helpful in the interpretation of elementary school assessments in Ontario.

Figure 3-1: Immigrants in Ontario elementary schools

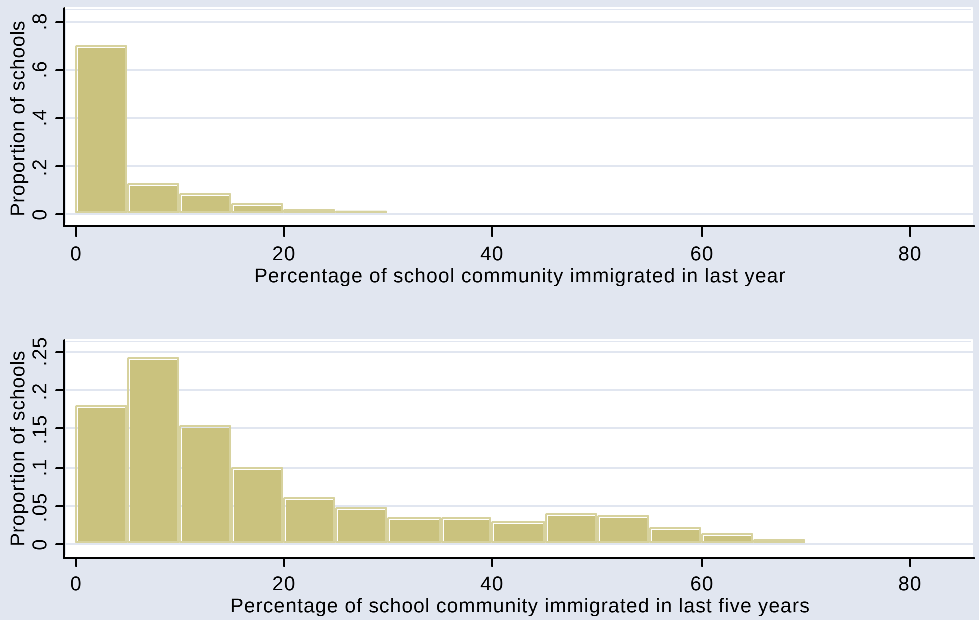
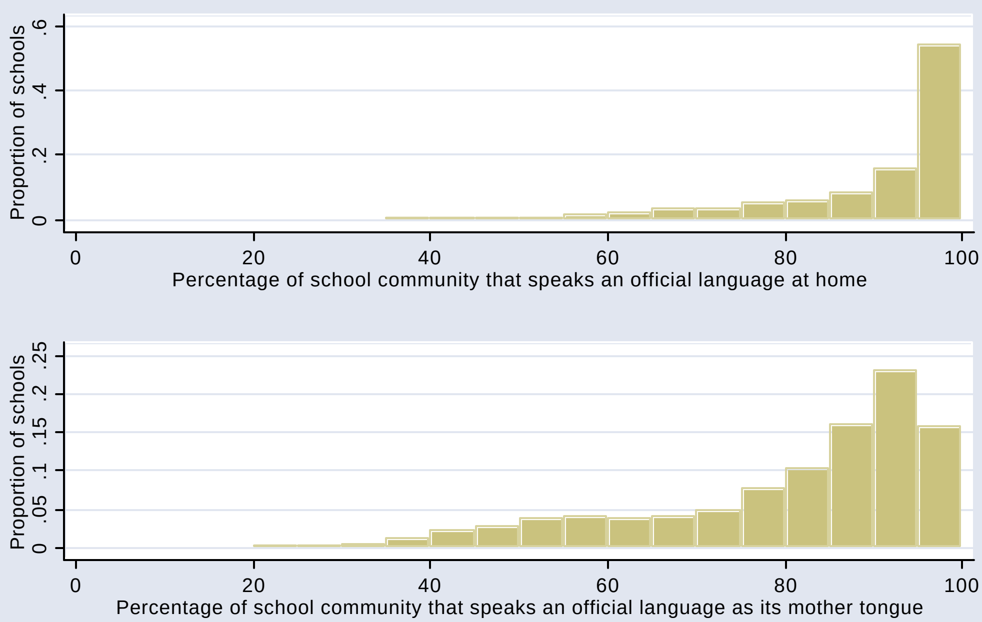


Figure 3-2: Language in Ontario elementary schools



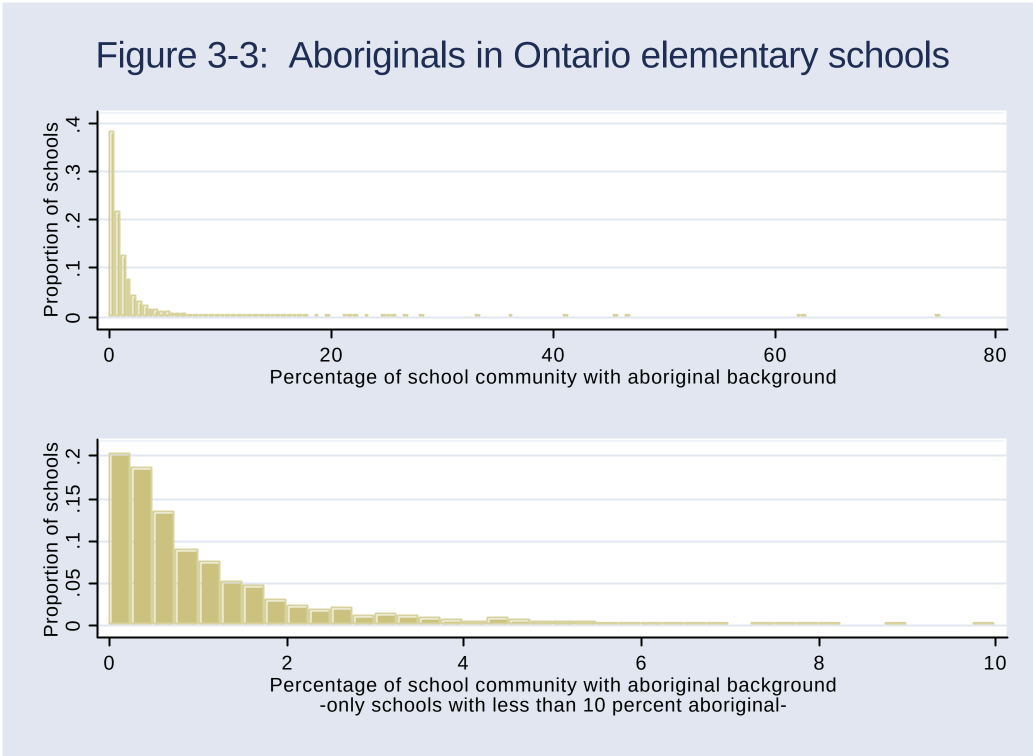


Figure 3-3: Aboriginals in Ontario elementary schools
Proportion of schools
0
.1
.2
.3
.4
0
20
40
60
80
Percentage of school community with aboriginal background
Proportion of schools
0
.05
.1
.15
.2
0
2
4
6
8
10
Percentage of school community with aboriginal background
-only schools with less than 10 percent aboriginal-

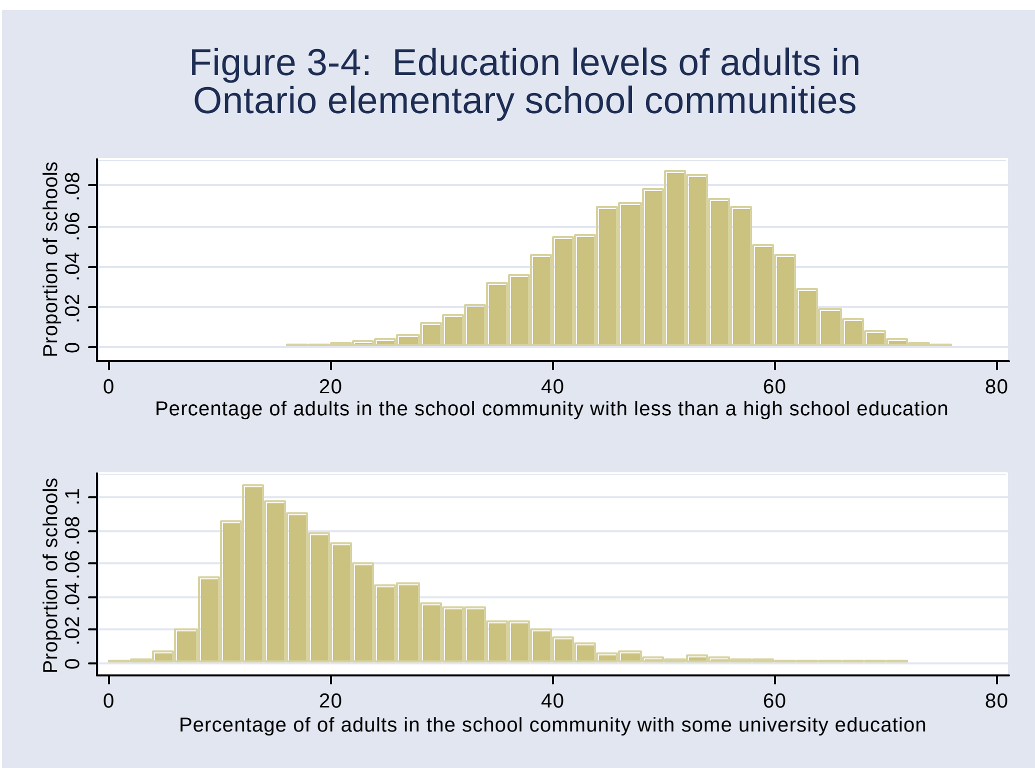
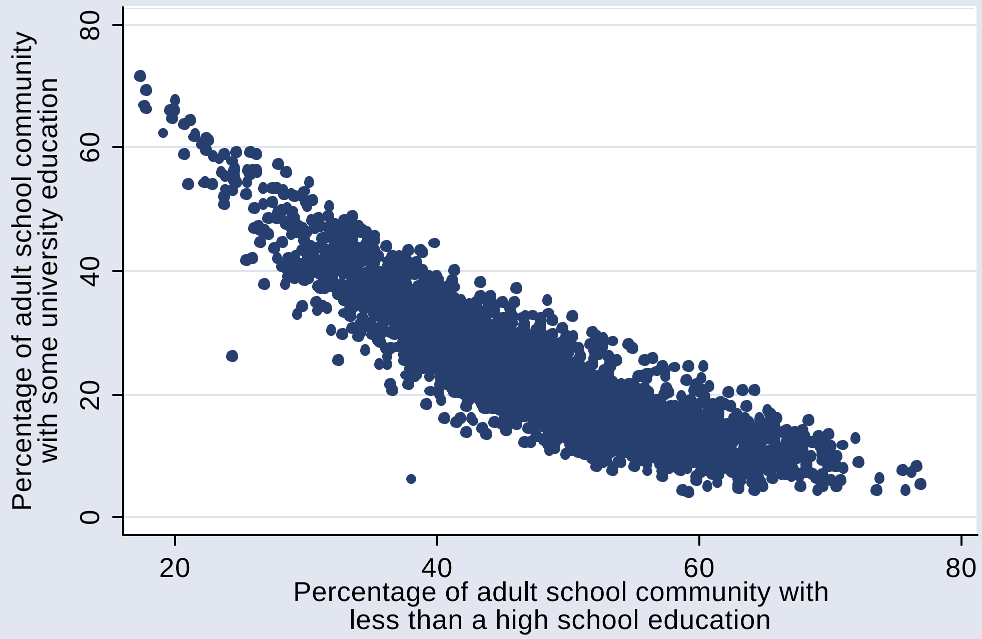


Figure 3-4: Education levels of adults in
Ontario elementary school communities
Proportion of schools
0
.02
.04
.06
.08
0
20
40
60
80
Percentage of adults in the school community with less than a high school education
Proportion of schools
0
.02
.04
.06
.08
.1
0
20
40
60
80
Percentage of of adults in the school community with some university education

Figure 3-5: The relationship between the education variables



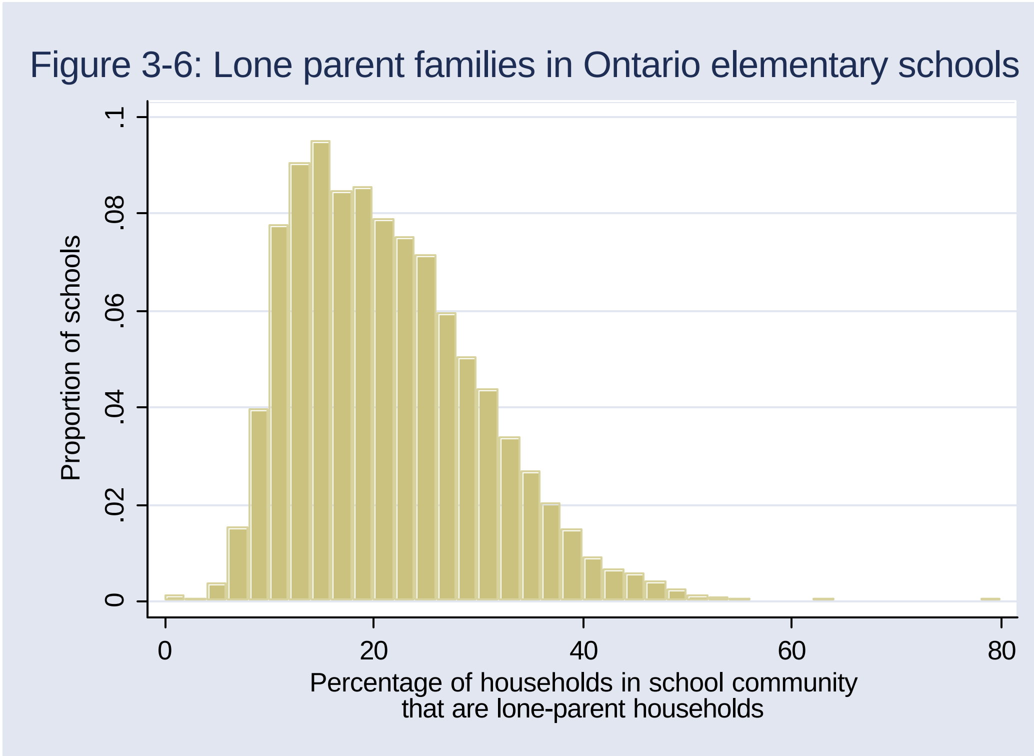


Figure 3-6: Lone parent families in Ontario elementary schools
Proportion of schools
0
.02
.04
.06
.08
.1
0
20
40
60
80
Percentage of households in school community
that are lone-parent households

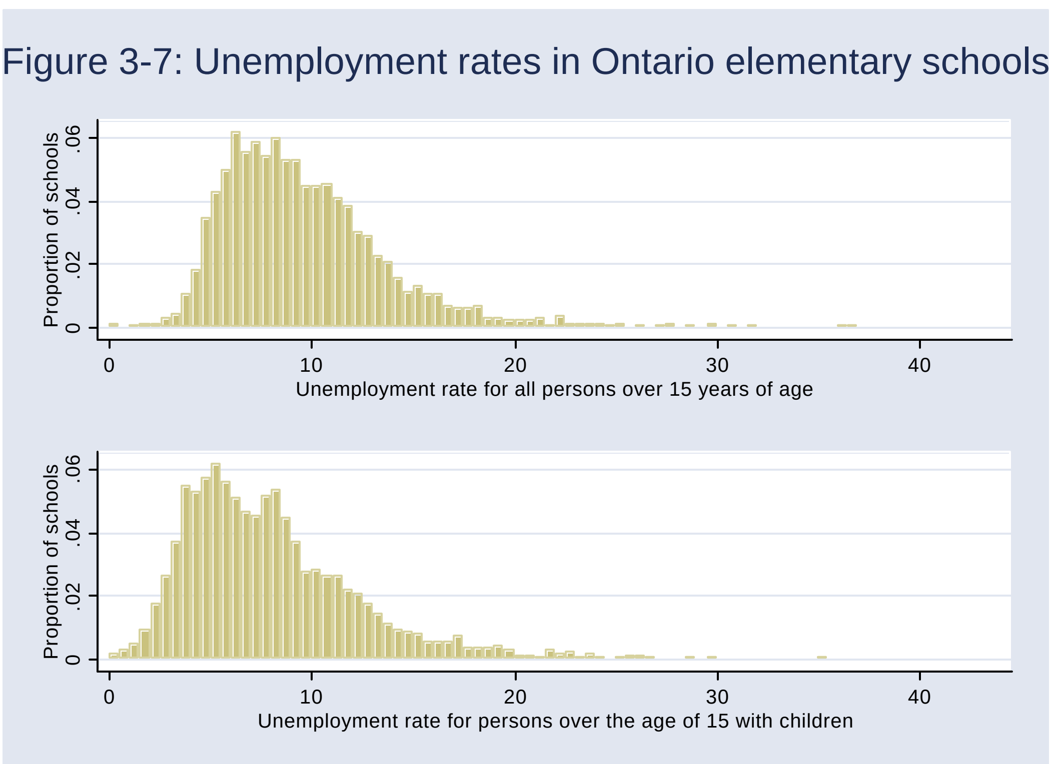


Figure 3-7: Unemployment rates in Ontario elementary schools
Proportion of schools
0
.02
.04
.06
0
10
20
30
40
Unemployment rate for all persons over 15 years of age
Proportion of schools
0
.02
.04
.06
0
10
20
30
40
Unemployment rate for persons over the age of 15 with children

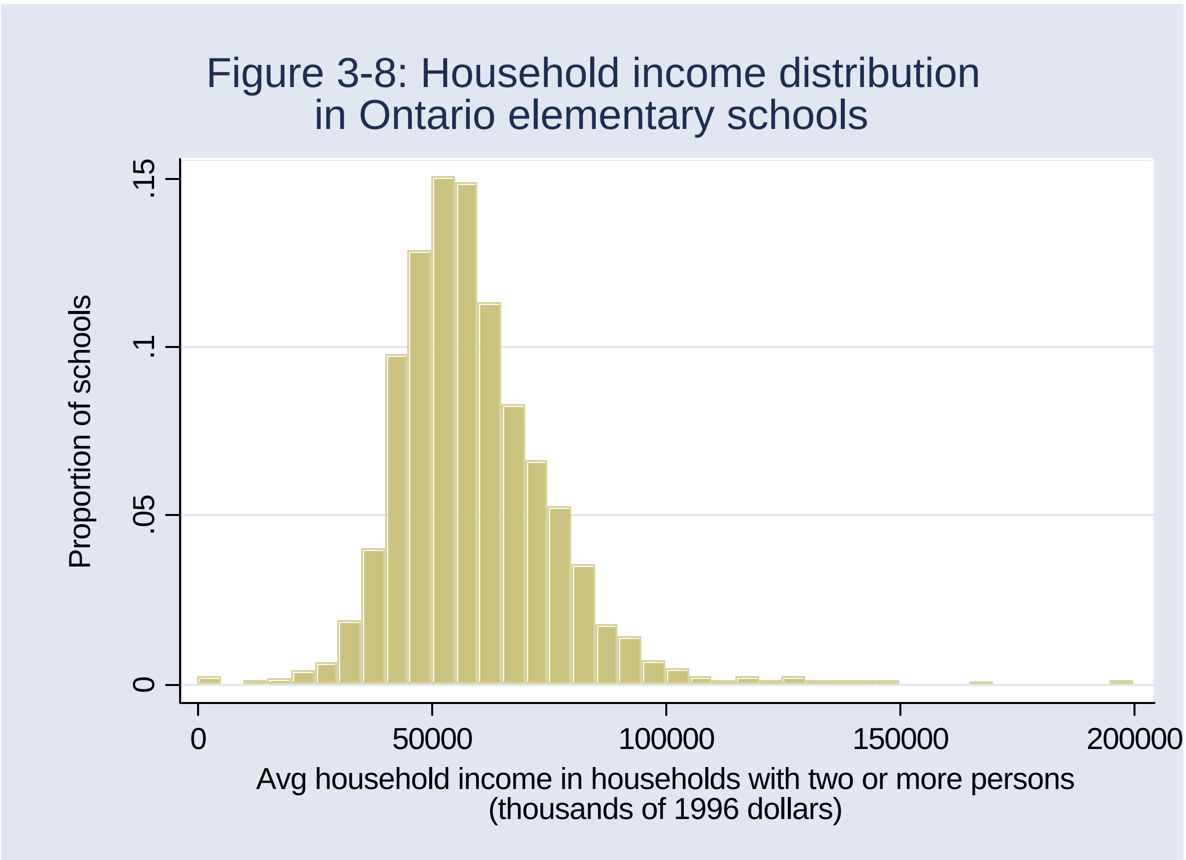


Figure 3-8: Household income distribution
in Ontario elementary schools
Proportion of schools
0
.05
.1
.15
0
50000
100000
150000
200000
Avg household income in households with two or more persons
(thousands of 1996 dollars)

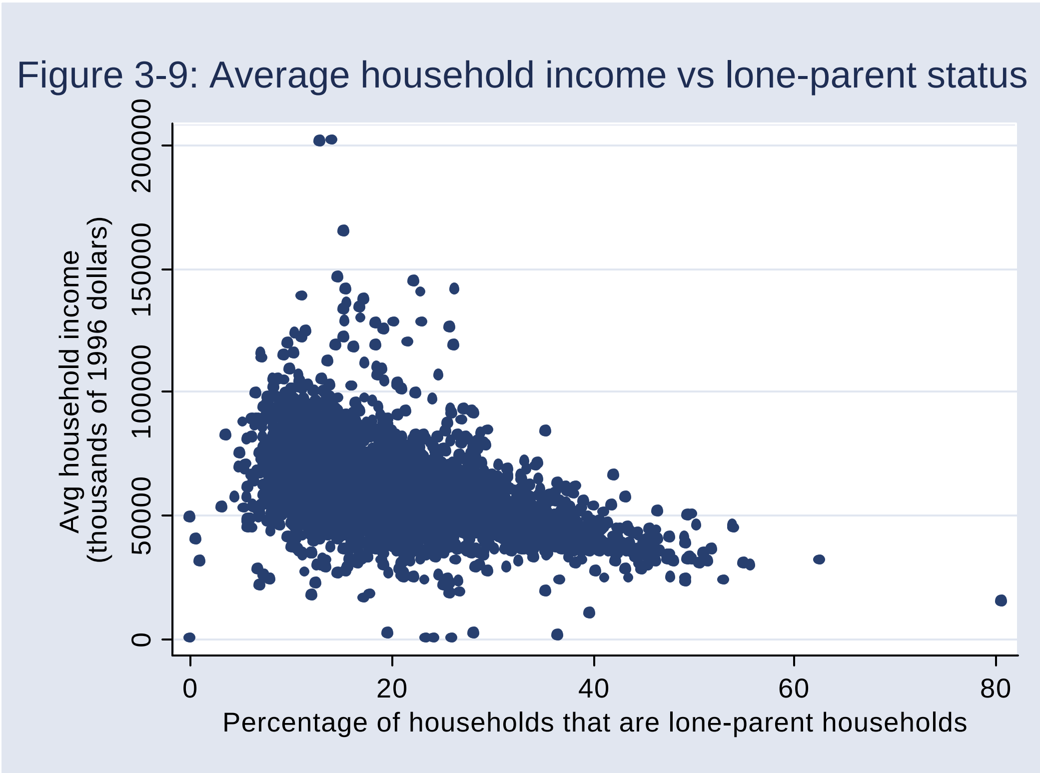


Figure 3-9: Average household income vs lone-parent status
Avg household income
(thousands of 1996 dollars)
0
50000
100000
150000
200000
0
20
40
60
80
Percentage of households that are lone-parent households

Figure 3-10: Mobility measures in Ontario elementary schools

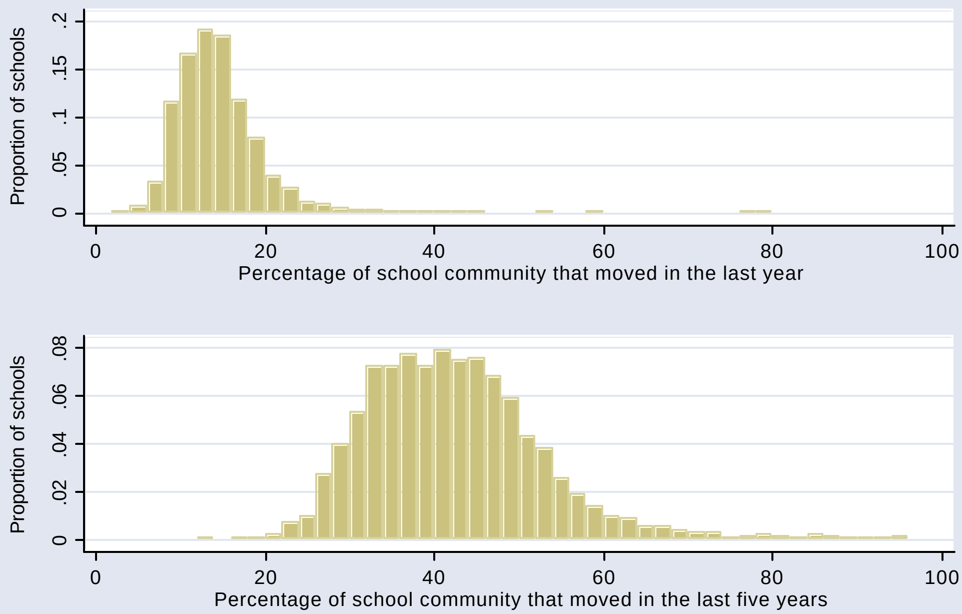


Figure 3-11: Housing types in Ontario elementary schools

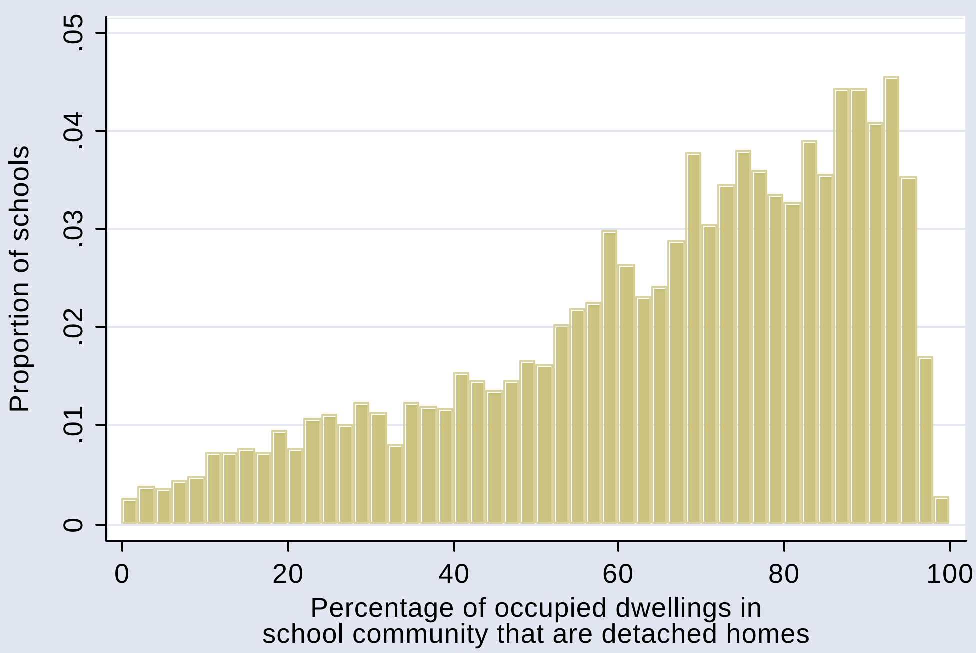


Figure 3-12: Enrolments at Ontario elementary schools

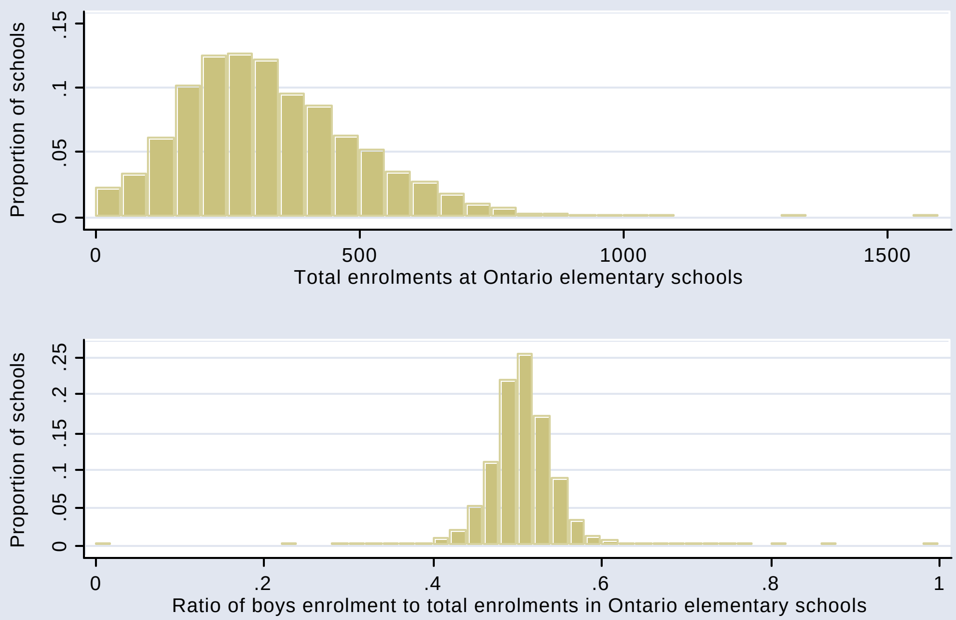


Table 3-1

	Public Boards				Separate Boards			
Year of Postal Code Data	Number of school	Minimum enrolment	Maximum enrolment	Average enrolment	Number of school	Minimum enrolment	Maximum enrolment	Average enrolment
1999-2000	2185	0	2119	355.9	1223	7	1887	345.79
with 1996 census	2185	0	2119	355.9	1117	3	1783	330.08
with 2001 census	2185	0	2119	355.9	1121	3	1870	342.99
2000-2001	2460	1	1333	368.1	1292	2	1810	338.4
with 1996 census	2459	1	1322	351.8	1291	2	1669	316.91
with 2001 census	2460	1	1333	368.1	1292	2	1785	338.3
2001-2002	2563	4	1429	350.4	1370	3	1677	319.4
with 1996 census	2563	4	1428	342.82	1370	3	1635	309.6
with 2001 census	2563	4	1429	350.4	1370	3	1675	319.36

Table 3-2

Participation in Postal Code Collection: Academic Year 2000-2001

	Total number of schools		Total number of elementary students	
	Public	Separate	Public	Separate
in provincial data	2573	1390	958 489	476 256
in postal code sample	2460 (95.6%)	1333 (95.8%)	905 526 (94.5%)	437 213 (91.8%)
in 1996 census	2459 (95.6%)	1322 (95.1%)	865 076 (90.2%)	409 130 (85.9%)
in 2001 census	2460 (95.6%)	1333 (95.8%)	905 526 (94.5%)	437 083 (91.7%)

Source: Ontario Ministry of Education website.
http:www.edu.gov.on.ca/eng/general/elemsec/quickfacts/2000-01/index.html

Table 3-3

Descriptive Statistics for Schools in Sample (4054 schools)

Variable	Provincial mean	Mean	Standard deviation	Minimum	Maximum	Number of schools with extreme
Percentage of immigrants in Canada less than one year	5.28	4.9	6.5	0	75.8	2833 < 5% 4 > 40%
Percentage of immigrants in Canada less than five years	21.2	18.9	16.6	0	82.6	723 < 5% 618 > 40%
Percentage with English or French as home language	90	91	10.7	35.7	100	2850 > 90% 9 < 50%
Percentage with English or French as mother tongue	78.4	80.9	15.8	24.1	100	1571 > 90% 209 < 50%
Percentage with aboriginal status	1.32	1.6	3.5	0	75.2	80 > 10%
Percentage of adults without secondary school diploma	47.63	49	9.6	13.1	76.9	-
Percentage of adults with some university education	24.31	21.5	10.5	0	71.5	245 >40% 327 < 10%
Percentage of children in lone-parent families	23	21.4	8.83	0	80.5	242 < 10% 690 > 30%
Unemployment rate	9.1	9.6	4	0	36.9	360 > 15%
Unemployment rate for persons with children	7.4	8	4.5	0	44	296 > 15%
Average household income for a two or more person household	$62,052	$58,824.4	$16,190.10	$0	$202,355.70	63 > $10,000 7 < $10,000
Percentage of dwellings that are detached homes	56.9	65.5	23.5	0.14	100	-
Percentage of households who moved in last year	14.7	14.4	5	2.4	79.9	418 > 20% 16 < 50%
Percentage of households who moved in last five years	43.1	42.5	10.8	13	95.8	-

Table 3-4

Measures of Income

		Mean	Standard Deviation
1	Average total income for all persons over age of 15	$ 25,835.00	$
2	Average total income for persons of age 15 - 44	$ 31,464.00	$
3	Average household income for households of two or more persons	$ 58,824.00	$
4	Average census family income	$ 56,400.00	$

Table 3-5

Correlation Matrix: Measures of Income

	Average total for all persons over age of 15	Average total for persons of age 15 - 44	Average household income for of two or more	Average census family income
Average total income for all persons over age of 15	1			
Average total income for persons of age 15 - 44	0.96	1		
Average household income for of two or more	0.97	0.94	1	
Average census family income	0.98	0.96	0.99	1

Table 3-6 Correlation Coefficients between the 16 variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Percentage of immigrants less than one year	1.00															
2	Percentage of immigrants less than five years	0.88	1.00														
3	Percentage of English or French as home language	-0.84	-0.94	1.00													
4	Percentage of English or French as mother tongue	-0.80	-0.96	0.96	1.00												
5	Percentage with aboriginal status	0.07	-0.15	0.17	0.19	1.00											
6	Percentage of parents without secondary school diploma	-0.07	-0.11	0.00	0.08	0.19	1.00										
7	Percentage of parents with some university education	0.26	0.34	-0.26	-0.34	-0.24	-0.89	1.00									
8	Percentage of children in lone-parent families	0.41	0.31	-0.32	-0.26	0.13	0.22	-0.07	1.00								
9	Unemployment rate	0.43	0.31	-0.34	-0.27	0.24	0.47	-0.29	0.68	1.00							
10	Unemployment rate with children	0.48	0.36	-0.40	-0.33	0.21	0.42	-0.24	0.68	0.91	1.00						
11	Average household income for two or more persons households	-0.15	0.02	0.08	-0.03	-0.30	-0.73	0.71	-0.50	-0.62	-0.59	1.00					
12	Percentage of households moved in last year	0.34	0.22	-0.22	-0.18	0.11	-0.02	0.06	0.56	0.34	0.39	-0.27	1.00				
13	Percentage of households moved in last five years	0.46	0.41	-0.36	-0.36	-0.08	-0.25	0.27	0.37	0.21	0.28	-0.04	0.75	1.00			
14	Percentage of dwellings that are detached homes	-0.63	-0.63	0.62	0.60	0.10	0.03	-0.23	-0.71	-0.48	-0.54	0.22	-0.54	-0.58	1.00		
15	Percentage of total enrolment	0.25	0.31	-0.25	-0.29	-0.23	-0.22	0.24	0.02	-0.05	-0.01	0.20	0.07	0.29	-0.21	1.00	
16	Percentage of male students	-0.14	-0.17	0.16	0.17	0.06	0.06	-0.12	-0.07	-0.03	-0.04	-0.04	-0.05	-0.09	0.15	-0.09	1.0

Table 3-7

The Elementary School EQUIP Variables

Community, Student and Family Demographics

1. Student enrolment by grade
2. Family income levels
3. Parents' educational attainment
4. Language at home and length of residency in Canada of the students
5. Students with special needs
6. Number of schools attended by a student since Grade 1

Preparedness to Learn and Early-Learning Support

7. Attendance in nursery school prior to enrolment

School Leadership

8. Indicators of leadership, planning and decision-making of the school

School Climate

9. A survey related to safety
10. Class sizes of Kindergarten, Grade 1 – 3, Grades 4 – 8 and an indicator of split classes
11. Number of students per teacher and per non-teaching support person
12. Types of special education available

Community-School Relationships

13. Composition of school council and an index of activities

Teaching and Learning Environment

14. Time allocation to reading, writing and mathematics

15. Accessibility to texts, other print, audio and video resources and software

16. Availability of assessment materials

17. Availability of computers at home and at school

18. Frequency of teacher meeting to plan and discuss curriculum

19. Range of parental involvement

20. Measures of teachers experience and qualifications

Student Achievement

21. Provincial achievement results in reading, writing and mathematics

Chapter 4: An analysis of achievement levels in Ontario elementary schools

4.1 Introduction

The EQAO states in its first provincial report, Page 1, “Assessment of student achievement is at the heart of our mandate” (EQAO Provincial Report on Achievement 1996-97) In this chapter, I begin the analysis of the EQAO data with the achievement results. In the next chapter, I move on to an analysis of the exemption process. Both issues are important in the interpretation of the assessment process. The structure of the achievement data is described in Section 4.2. A comparison of year-over-year results using the same assessments and then a comparison of results within a year on different assessments, reading, writing and mathematics, is presented in Section 4.3. Section 4.4 measures the relationships between the social and economic factors that describe a school in the previous chapter and the achievement data. Some emphasis is placed on the factors that would be readily available at a school level without the census. In Section 4.5, a sample of 10 percent of the schools available on the EQAO website in 2000-2001 and 2001-2002 is used to create a different set of context variables than those described in Chapter 3. These context variables are available by grade at the school, the grade actually doing the assessment, and not for all the students in the school. The three EQAO context variables are: the percent of students in ESL programs; the percent of students in special education programs; and the percent of students who do not speak English at home. In addition, it is possible to identify French immersion schools. The chapter closes with a brief summary of what we have learned to date.

4.2 The structure of the assessment data

In each of the four academic years studied, 1998-99, 1999-00, 2000-01 and 2001-02, there are data from a Grade 3 assessment and a Grade 6 assessment.[14] These assessments are given to all students in Ontario at schools that receive public funds. There are three assessments in each grade: reading, writing and mathematics. The assessments do change slightly in format from year-to-year. An enormous effort is made by the EQAO to make the assessments comparable from year to year. There is a considerable effort to monitor testing, including random visits to schools during the assessment process. Since the goal is to improve learning outcomes, if the assessment is a useful tool, it needs to be comparable across years so that learning outcomes can be compared across years. A great deal of effort is made to make assessments comparable. This includes grading at central locations. Assessments are returned to students in the following academic year. The results contain more detail than used in this analysis.. Each assessment contains “strands” which identify the areas of strength and weakness in learning in a particular student or at a particular school. These strands are aggregated into an overall score on reading, writing and mathematics for each student.

These results are then further aggregated across all students at a school in a given grade. The most common case is that a school contains both Grade 3 and Grade 6. Some schools contain only Grade 3. Others contain only Grade 6. The school level aggregation presents results as percentages of

[14] In these four years, the data are available in machine-readable form. Data are not currently available in machine-readable from the first two academic years of testing, 1996-1997 and 1997-1998. In these years only Grade 3 assessments were carried out.

students in the grade at the school, Grade 3 or Grade 6, in different categories. The percentages are presented as integers and may not add to100 percentage points due to rounding. If a school contains more than one class (which is very common) the results are presented with the classes aggregated. If there are fewer than 15 students in a grade at a school, then the results are suppressed for privacy reasons. Results are presented using two methods.

Method 1 (the EQAO terminology) places all students at a school into categories. When there is sufficient material to grade, then a student is assigned to one of four categories: Level 1, Level 2, Level 3 and Level 4. Level 3 indicates the student is meeting curriculum standards. Level 4 indicates that a student is exceeding curriculum standards. The sum of the percentage of students at Level 3 and at Level 4 is the principal measure of the success of the elementary school system used in this analysis. These are the students able to carry out tasks in a way that clearly indicate the curriculum has been mastered. The other students in the school cannot carry out these tasks. The other students fall into two (or three) further categories. Some students undertake the assessment, provide enough material to make the assignment of a level possible, but achieve only a Level 1 or Level 2. In either case, the curriculum is not mastered. Some students undertake the assessment but do not provide enough material to be assessed.[15] A few records in the system are actually lost. This is a tiny percentage of the overall number. However, a substantial percentage of students are exempted from undertaking the assessment. The exemption process will be considered in detail in the next chapter. The local principal decides is a student is exempt based on criterion provided by the EQAO. The aggregation of results

[15] These students are not treated consistently across the 4 years of the data. In the last year, they are recorded separately. In the first three years, they are recorded as a single group.

used in this chapter's analysis is:

Category One(C^1): percentage of all students in the grade at that school in either Level 3 or Level 4

Category Two(C^2): 100 (percentage points) minus the percentage of students formally exempt minus the percentage of students at Level 3 or Level 4 in that grade at that school. This combines Level 1, Level 2 students with the students that provided insufficient material to grade and the papers that are lost.

Exempt(EX): the percentage of all students in the grade at that school formally exempt from all three tests.

The terms in parentheses are the labels used for these variables in the equations.

The EQAO also presents results in a Method 2 format. Here the percentage of students in each of Levels 1,2,3,and 4 from the total of all students who actually provided sufficient material to be assessed is presented. Recall that Level 3 and Level 4 students meet provincial standards. It is much less clear what this presentation of results might mean. If the exemption process were the only significant source of missing assessments AND the exemption process is applied consistently across boards and schools (both hypotheses considered further in the next chapter), then the Method 2 results might be considered measures of teaching success from the subset of students with the potential to succeed in mastering the curriculum. As soon as this sentence is written, the difficulty of assessing the "potential" to master the curriculum becomes apparent. Further discussion of this method of presenting results is deferred to the next chapter. The EQAO itself suggests that the Method 1 presentation is more reflective of its mandate to help the education system meet the needs of all children in Ontario.

The variable Category 1 (C^1) is the variable analyzed in the rest of this chapter.

4.3 A first look at achievement results

The data incorporate an enormous amount of information on student achievement and the assessment process. In this section, overall patterns are presented, patterns of results by year and by type of assessment. Table 4-1 shows the number of schools in each year of results and the percentage of students (averaged across schools) in Category 1, Category 2 (as well as its two sub-categories) and in the Exempt category.[16] A visual picture of the distribution of the Category One variable across schools in Grade 3 and Grade 6 is presented in Figures 4-1 and 4-2. Figure 4-1 shows its distribution across years and assessments. This variable ranges from 0 to 100 percent. Its distribution in Figure 4-2 is approximately bell shaped. The percentage of students achieving a Level 3 or Level 4 appears to have increased over time. The school achievement results constitute an enormous data set over time and across schools. It is necessary to look for patterns to provide a useful interpretation of this enormous mass of results.

One important tool used in this analysis is a regression analysis on dummy (indicator) variables. A dummy variable takes on a value of unity when an assessment result at school “i” , an assessment of type “j’ - reading, writing or mathematics - in year “t” is a member of a group that shares a common

[16] Appendix Table 4.1 shows a slightly different breakdown of this data where the percentage of students involved in the assessments in each of the three categories is presented. This data is found in the Provincial Reports in each year. The units of observation available for this study are schools (usually with multiple classes in a school). The difference between the two tables will be in the fact that a student at a small school is more heavily weighted in Table 4.1 and all students are equally weighted in Appendix Table 4.1. This difference is not very important.

characteristic. The value of the dummy is zero when the observation is not a member of the group. The variable $C^1_{j, i, t}$ (the percentage of students in Category 1) in the equation

$$C^1_{j\ i,\ t} = a + d_{1999}\ D_{1999} + d_{2000}\ D_{2000} + d_{2001}\ D_{2001} + \mu_C + u_{j,i,t} \qquad (4\text{-}1)$$

is described by a base value a and a series of shift factors, the interactions between coefficients and dummy variables. This type of equation will appear repeatedly in the analysis and needs to be understood. In equation (4-1), this example, the indicator or dummy variables are associated with a year in which the assessment takes place. D_{1999} is one for an assessment drawn from the 1999-00 academic year and zero in other years. The group studied is all assessments written in 1999. d_{1999} is the coefficient on that dummy variable. Suppose the value of d_{1999} is 7. This means that in 1999-00 about 7 percentage points more students achieved either a Level 3 or Level 4 results on the assessment than in the base year, 1998-99. The base year in equation (1) is the year for which there is no dummy variable, in this case an assessment given in 1998-99. The coefficients on the other dummy variables, d_{2000} and d_{2001} have similar interpretations. If equation (4-1) is estimated, and all these coefficients were positive, then assessment results have improved since the base year. If the coefficients on the dummy variables were to increase each year, then assessment results are improving over time.

A very useful way to think of Table 4-1 is that the achievement results are grouped by the year in which the particular type of test was given. For example in the Grade 3 reading assessment in 1998-99, 43.17 percent of students (averaged across schools) achieved a Level 3 or Level 4. In 1998-99, the value of all of the other dummy variables is zero. The percentage of students achieving a Level 3 or Level 4 then increased substantially in 1999-00, fell slightly in the following year and then increased again in 2001-02. Figure 4-1 shows the improvement in results. It is a graph of the second column of Table 4-1 organized by year. It is an interesting graph. It does show an improvement in time in the assessment results. However, as in all analyses of data, it is important to know the likelihood that the change in results is statistically significant and not just due to random changes. To ascertain what has happened, it is necessary to return to equation (1) and estimate the 4 parameters of equation (1) with the appropriate technique. Using the appropriate statistical technique is important to getting the correct answer to the question: Are the changes in assessment of statistical significance so that the improvement from year-to-year is not just luck.

The problem is that the data set for school results is not one where all assessment results are independent. A roll of a die on a fair die is part of a sequence of independent events. Observing a six on your first roll of the die generates no information about the probability of observing a six on the next roll of the fair die. However, when we observe a school with a high value on a reading assessment result in one year, a high value of the variable C^1 in 1998-99, we know much more. Various factors would contribute to that high results in 1998-99 in reading. Some factors would be associated with the class - either the mix of students or the teacher. These would then affect both the mathematics and the writing results in 1998-99. Some factors would be associated with the school. Some may be associated with the teacher who may stay another year, and the same families and types of families send children to the Grade 3 at that school in subsequent years. The school-level factors do not change from 1998-99 to 1999-00. Thus we would expect a high value of C^1 in an assessment at a school to be associated with high values of other assessments at that school both in the same year and in other years. This is true across years of data on the same assessment for the same school and within the year on different assessments in the same grade at the same school.

A correct estimate of the parameters of equation (4-1) can pull out the year-over-year effects. The key is understanding the behavior of the level of the assessment result on assessment j at school "i" in year t. It is composed of the sum of the constant term, a and the coefficients on the three dummies multiplied by the values of the dummies for that observation and the sum of two random terms: $\mu_S + u_{j,i,t}$. The first random term, μ_C, is the school effect that persists at that school (school i) over all the years t where we have a result at that school. We are not able to estimate that effect directly in this equation. But that effect does change the estimates of the standard errors on the coefficients of interest, the estimate of a and the three estimates of d. Here is the intuition. We want to know if the mean value of the assessment result is actually different in 2001 than in 1998. This is an estimate of $d_{2001.}$ It looks like we have about 3500 different observations of each assessment result in each year (one for each school). However, if there was a result from every school in every year,12 of those results are linked by the fact they occur at the same school. The results are not fully independent pieces of information on the assessment process. The joint error term at each school is a portion associated with the school (μ_S) and another portion that is random at that school in that year ($u_{j,i,t}$). In the language of the statistical estimator, each school is a "cluster." It is straightforward to take the clustering effect into account, see Deaton (1997), chapter 2, for the details. When the clustering is taken into account, the standard errors of the a coefficient and the group of d coefficients are correctly estimated and we can then ask about the behavior of the assessment results over time.[17]

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[17] The command in Stata is regression with the option "cluster". The correction to the standard errors is discussed in detail Deaton (1997) and in the Stata manuals. (Stata)

Table 4.2 presents estimates of the behavior of the results on the same assessment over the four years. The estimates of the coefficients and their standard errors appear for each assessment. Notice the standard errors are quite large for the number of observations. It is quite difficult to tightly estimate the average value of C^1 in a year. Test of a variety of null hypotheses are implicit or explicit in Table 4-2. In the fourth column, the null hypothesis asks if the 2000-01 assessment and 1999-00 assessment are equally different from the 1998-99 assessment. The second column asks if the 2001-02 and 2000-01 assessments are equally different than the 1998-99 assessment. The last hypothesis test asks if the 2001-02 and 1999-00 assessments are equally different from the 1998-99 assessment. Tests of three null hypotheses are presented in listing the coefficients on the dummy variables for each academic year other than 1998-99. Finally the standard errors on the coefficients in the first three columns ask directly if the assessment results in 1999, 2000 and 2001 differ from the 1998 results. When these coefficients on the dummy variables are more than 2 times their standard error (the values in parentheses) then assessment results in these years are higher than in the base year.

What is learned from all this? It is very clear that average results across the four years on the six tests are usually different. For example, the Category 1 variable is, on average, 4.29 percentage points higher in 1999-00 than in 1998-99. Reading levels in Grade Three appear to have improved from 1998-99 to 1999-00. Note this is only the appropriate interpretation if the assessment was equal in difficulty and graded in the same way in all of the years. Certainly that is the goal of the creators of the assessment. I will use that language for convenience, readers will simply have to recall that a higher value of Category 1 could also be the result of making the assessment easier or giving a higher score to the same work. There is no way in these results to separate these two hypotheses. I leave that discussion to the experts in the education field that will and do work with this data. Even with this caution, the results presented in Table 4-2 are very interesting.

First it is clear that most of the assessments, 15 of 24, generate a different average than the 1998 base. In general the values of the coefficients on the dummies are positive and significant (there are no negative and significant coefficients). So the ability to master the curriculum appears to have increased since the 1998-99 assessment.[18] It is quite promising that the coefficient on the 2001 dummy is the largest of the three coefficients estimated in 4 of the 6 cases. These Grade 3 and Grade Six students would have been in elementary schools since the beginning of assessments in 1996-97. In this interpretation, the emphasis on accountability and a clearer curriculum resulted in stronger assessment results. There are two exceptions to the improvement in results. The Grade 3 mathematics assessment result in 2001 was significantly lower than that in 2000-01. The same statement can be made when comparing the 2000-01 Grade 6 mathematics assessment to the 2001-02 outcome. The drop is quite a bit smaller than in the Grade 3 case. However the reading and writing scores seem to be improving, both relative to 1998-99 and even over the 3 subsequent years in most cases. These improvements are statistically significant conditional on the validity of the assessment and its grading, that is, the assessment of the assessment. I would say that the likelihood that the assessments are exactly comparable is not high. Otherwise it is difficult to account for the two drops in scores in mathematics. It is fairly straightforward to think of a situation in which an assessment was accidentally increased in difficulty. It is harder to think of a situation in which a large sample of fairly similar children and teachers reduce their

[18] It would be very interesting to have the data from the 1996-97 and 1997-98 Grade 3 assessments. This data are not available in machine-readable form (or in any direct form) by school.

performance from one year to the next - did they unlearn previously successful teaching techniques? For this reason, using the assessment results to evaluate relative school success, an exercise undertaken in Chapter 6, may be a more promising use of the assessment process. The variation in assessment results over time is critical component of the ability to any analysis, including the analysis of the effects of context on relative school outcomes.

A very similar equation to (4-1) is

$$C^{1}_{j\,i,\,t} = a + d_{write} D_{write} + d_{math} D_{math} + \mu_S + u_{j,i,t} \qquad (4\text{-}2)$$

Notice that in Table 4-3 the base test is the reading test and that equation (4-2) is estimated separately for each year of results. Table 4-3 makes it very clear that within a year the assessments have different average values of the variable Category 1. In the same manner as the estimates of equation (4-1), the estimates of equation (4-2) tell us that Grade 3 students, in every year, were more likely to achieve a satisfactory level of achievement in writing and mathematics than in reading. By Grade 6, this differences appear to be reversed, although the differences are much smaller. It is interesting that by Grade 6, the reading disadvantage is reversed and the reading and writing skills appear to have become relatively worse. The differences remain statistically significant. Again the difference is difficult to interpret. If the assessment instrument is a good instrument and correctly measures the need of students to master the curriculum, then these dummies state that in all years Ontario students are relatively better at writing and mathematics than at reading. By Grade 6, these differences are much smaller and in many years not significant. For the purpose of understanding the effect of social and economic factors on achievement results, it is important to take into account variation in the mean assessment result. Measuring the effect of social and economic factors on educational outcomes is the next step.

4.3 What social and economic variables from the census best explain achievement results?

In Chapter 3, a long list of social and economic variables that describe the context of a school was constructed. It is unlikely that all these factors are equally important in explaining variation in school results. Some of the factors are near duplicates of one another. It was also noted that some factors could be easily and inexpensively measured at a school level. There was was a suggestion that particular attention be paid to these factors. The same statistical issue that arose in the estimation of equations (4-1) and (4-2) arises in the estimation of the relationships between context factors and achievement results.

As noted earlier in this chapter, in the "usual" situation in statistics, each observation of an event is considered to contain new information. The roll of the die was the example of such a situation. The census is another example. Because all Canadians are included, the age of each person in the census provides some useful new information about the exact average age of Canadians. Admittedly, when the sample is very large, the additional information is not very useful. In the setting of equations (4-1) and (4-2), we have many observations of assessments, up to 24 at a specific school (12 Grade 3 and 12 Grade 6 assessments). There are about 3400 schools.[19] It looks like there are up to 3400 x 24 = 81,600 observations of the effect of school variables on achievement. In a sense, this is true, all of this data contributes to our knowledge about the relationships between the results and the school variables.

[19] It is more complicated than this since some schools have only Grade3, others only Grade 6 and most have both grades. Some schools are French immersion schools and can opt out of assessment in the non-immersion languages in some years. About 75 percent of the schools in the sample contain results from all years of assessments. The data set is quite untidy.

But it is necessary to be much more careful. A given school shares, over all assessment results, the context information that describes the school.[20] Not all of the information about the relationships between results and school factors from a given school is "new" information. This fact must be taken into account in estimating these relationships.

The equation

$$C^{1}_{j,i,t} = a + d_{test}\ D_{test} + ß_{X}\ X_{i} + a_{C} + u_{j,i,t} \qquad (4\text{-}3)$$

is now the equation to be estimated. There is a constant term in this equation but it does not have a simple interpretation as the average value of C^1 on the base year for that type of assessment.[21] However the coefficients on the 11 (or 23) dummy variables in each equation do have a clear interpretation, they measure the change in the percentage of students achieving Level 3 or Level 4 on the test that dummy variable represents. This increase in the achievement level is, as in (4-1) and (4-2), relative to the test not included in the set of dummy variables. The results in the previous section (Tables 4-2 and 4-3) told us that it was very important to allow the different assessments in different years to have different average results. These effects are included "in passing" in estimating equation (4-3). These effects are not of central interest.

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[20] There is some class-specific data on the EQAO website on the context of a year at a school. A sample of that data is used below as a check on the census data.

[21] The constant term is the average achievement on the base year and base type of test evaluated at the "average" school - average in the sense of the context variables. The constant term no longer has a useful direct interpretation.

The central issue is to relate the context variables to school achievement results. Imagine that X_i is one such variable. Notice that its value at school "i" does not vary by year of test. All the years of assessment are simply years between the censuses. The census variables were averages from the postal code locations of the students in 3 academic years. The value of the parameter $ß_X$ in equation (4-3) is a measure of the relationship between the result, the value of Category 1 in an assessment at a school, and the value of the variable X at all schools. To be concrete, suppose that X_i were income in thousands of dollars and C^1 is the percentage of students at Level 3 or Level 4. A value of $ß_X$ equal to .002 means that as average household income increases by 1000 dollars, then on average across all schools and assessments, the value of C^1, increases by 2 units or, 2 percentage points more students achieve the provincial curriculum. The value of $ß_X$ is estimated using an ordinary least squares regression of equation (4-3). Its statistical significance must also be determined.

The problem considered in the previous section, school clustering, also arises in deciding if X_i is an important variable, that is, is $ß_X$ different from zero. The standard error of the estimate of $ß_X$ is critical in testing this hypothesis. Because the error term in (4-3), $a_C + u_{j,i,t}$, is a sum of the school-specific random effect and a random effect associated with that class at that school in that year, the estimates of the standard error of $ß_X$ must take this effect into account. When equation (4-3) is estimated over 3500 schools and 12 Grade 3 assessments at each school, there would be a constant term, 11 dummy variables for the 11 tests and, in this example, just the one context variable, X_i.[22] In

[22] It may be of interest to the reader to know just how large the impact of clustering is on the standard errors of the coefficient $ß_X$. If equation (4-3) is estimated using OLS and without a correction to the standard errors for the school-clustering effect, the coefficient on the level of income as the context variable for Grade 3 results is ???? with a standard error of ????. When the school-

reality, there is more than one context variable, the list of possible context variables using the census was presented in Chapter 3. If there were two context variables, then the equation estimated is:

$$C^1_{j,i,t} = a + d_{test}\ D_{test} + ß^1_X\ X^1_i + ß^2_X\ X^2_i + a_C + u_{j,i,t} \qquad (4\text{-}4)$$

There is no reason to limit the analysis to two context variables. We had a long list of possible variables in Chapter 3.

The biggest problem, already noted in Chapter 3, is that the various social and economic variables are closely related. Tables 4-4, 4-5 and 4-7 present relationships between various combinations of the variables and the percentage of students achieving Levels 3 or 4, the variable called C^1. Table 4.-4 looks at the Grade 3 assessments, Table 4-5 looks at Grade 6 assessments and Table 4-7 presents results that combine the information on the two assessments over all schools. The general format of the equations estimated now follows equation (4-4) although there are more than two context variables. When the equation is estimated with just Grade 3 assessments, then there are 11 dummy variables for 11 of the 12 assessments. In the Grade 6 case there are also 11 dummy variables. In Table 4-7, when the effects of social and economic variables on achievement is measured using both Grade 3 and Grade 6 assessments, then there are 23 assessment-related dummy variables. These variables are always statistically significant. The coefficients on these variables are not presented. Beyond the assessment dummy variables, what social and economic variables best explain variation in

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clustering effect is taken into account, the correct estimate of the standard error is ????. This is an important correction to make. (TO BE ADDED LATER) school results? An equally interesting question to ask: How much of the variation in achievement results can be explained by social and economic variables?

The Grade 3 assessments are studied using the results found in Table 4-4. The answer to the second question: How much of the variation in achievement results can be explained by social and economic variables? is discovered in looking at the R^2 (R-squared) that appears in the last line of Table 4-4 for the various versions of equation (4-4) estimated. If the R^2 were unity or close to unity, then all of the variation in assessment results would be explained by the social and economic context of the school. This is simply not the case. In the "best case" about 25 percent of the variation in achievement results is explained by the social and economic context of the school. Fully 75 percent is unexplained. This is NOT a surprising result. Kane and Staiger (????) show that in with individual student assessment results, there is so much variation across the individuals at the primary level, that social and economic factors necessarily do not fully explain achievement results. However, it is still necessary to take out the predicted effects of social and economic factors, to make the school achievement results meaningful and comparable across schools. What factors make a difference?

There are only a few surprises in the list of social and economic factors that are related to strong achievement results. The coefficients on these factors are presented in the second and third columns of Table 4-4. Standard errors (corrected for the clustering effect) appear in parentheses beside each coefficient. The coefficient on each variable is the effect of a one unit change in that variable on the achievement level in grade 3 - the average over the three assessments. If there are a large percentage of lone parents in a school, then achievement results fall. The last column (8) of the table helps to scale the results. It takes the estimated coefficient and calculates for a one-standard deviation change in the value of the variable, how large is the predicted effect on school achievement levels. For example, in the lone-parent variable, the average elementary school community has 21.4 percent lone parents. The standard deviation of the lone parent descriptive variable is 8.9 percentage points. This means 66 percent of schools fall within one standard deviation of the mean value of a variable in most cases. So at a school with 8.9 percentage points more lone parents than another school with the average percentage of lone parents, all other school context variables being the same, the achievement score would be predicted to fall by 1.07 percentage points (from the last column in Table 4-4). The rest of the table is read in the same way.

If a larger percentage of the school community speaks one of the official languages, then achievement results increase. If a larger percentage of the school community is aboriginal, then achievement results fall. If a larger percentage of the school community is a recent immigrant to Canada (in the last year), then achievement results rise. This is actually quite a strong effect and somewhat counter-intuitive. Most people would think immigrants would have difficulty on a standardized test, in most cases, they are not being taught in their home language. However, the immigrant effect is measured after the language effect is already taken into account. The positive results of recent immigrants is likely because immigrants to Canada are not a random sample of persons living in the country they just left. Instead immigrants are precisely those people willing to make a move to improve their situation. Such persons are often moving to help their children to a better opportunity set. These children do well in school all else being equal.[23]

[23] An even more cheerful interpretation would be that the Ontario school system meets the needs of these immigrant children very well.

There are three economic variables in the set of context variables. They are the percentage of the school community living in detached housing, the average income of the school community and the unemployment rate in the school community. These variables have the expected effects. If there is more detached housing, achievement levels are predicted to rise. If income increases, achievement levels are predicted to rise. There is an additional note concerning the income variable. The variable in the estimated relationship is actually the natural logarithm of income although the level of average income is included in the table. Income is highly skewed to the right (see Figure 3- 8). The logarithm of income has a more normal distribution. To understand the effect of income on school results, consider a doubling of average income from one school to the next. If we started at 59,000 dollars, this would move a school community to an average income of $118,000. This is an enormously high average income. The log of income variable would increase by .67 units and the predicted achievement level would rise by 4.8 percentage points. This is a very large effect. Schools do vary widely in the level of average income in their school communities. The last economic variable is the unemployment variable. If there are more unemployed household units in the school community, achievement levels are predicted to fall. This is independent of the reduction in income associated with unemployment.

Both mobility variables are significant explanatory variables on the level of acheivement in Grade 3 assessments. An increase in either the percentage of the school community that moved in the last year or even in the last five years reduces achievement results. The first effect is much stronger than the second effect.

There is, as expected, a very strong effect of parental education background. This is the second most important variable in practice, after household income. If the school community has a large percentage of adults who have not completed secondary school, then achievement results are lower. Using the metric of the last column of the table, this result is quite strong - if there are 9.5 percentage points more adults without a secondary diploma, then achievement results are predicted to fall by 2.47 percentage points. Similarly if there are 10.5 percentage points more adults with some university education, then achievement results are predicted to rise by 2.31 percentage points. A swing in a school community reducing the percentage of the adult community from 10 percentage points without a high school diploma to an increase of 10 percentage points in adults with some university (a very plausible change in a school community) would move predicted achievement results by 5 percentage points.

It was noted earlier that three of the variables in the list above are very easy to collect at the school level. They are the one-year mobility measure, the language variable and a measure of the percentage of the school community that lives in detached housing. If these three variables were asked and were able to do all the work in the explanation of school achievement results, then it would not be necessary to collect the other variables. Unfortunately this is not the case. The R^2 falls by a large amount when only three variables are used. The other variables clearly play an interesting role.

The final variable included in the base case is a measure of school enrolment. This is included because of the controversy in educational policy about a school size effect. It seems clear that the effect of school size on achievement is not statistically significant.

Table 4-4 also presents estimates of the models with interaction variables on the type of assessment. It need not be the case that the effects of lone parenting on reading, writing and mathematics assessments are equal. An interaction variable is the product of the lone parent variable and the dummy variable by type of assessment. The coefficient on the interaction variable measures the interaction effects. Some of the coefficients on the interaction variables are statistically different from zero, others are not. There is no interaction effect of lone parenthood or of immigration. There is no interaction of enrolment by assessment. There are quite a few significant interaction effects on achievement in the mathematics assessment. Rather oddly, high income and well-educated parents (the two are related) are associated, through the interaction effect, with lower mathematics scores. High unemployment and a large aboriginal component also have a differential effect on math scores. Language has a differential and negative effect on math scores. It is quite interesting that the language component reduces math scores differentially. Most of the significant interaction of coefficients are the mathematics column, there is relatively little differentiation in the reading versus writing column. That is what you would expect to see, presumably reading and writing skills are more closely related to each other than to the skills needed to master mathematics. Are the interaction variables worth adding to the explanatory equation? The increase in explanatory power with these variables is tiny. The increase in the R^2 is very small (in the third decimal place). Most of the time, the base model with all the variables remains the model of choice.

The second last column in Table 4-4 presents results for a balanced sample. This means all the schools used in the analysis participated in all the assessments in Grade 3. The effect of the income variable is a little bit larger and the effect of the one-year mobility is a little bit smaller. The effect of the low-education variable is slightly larger, the effect of the high-education variable slightly smaller. It is noteworthy that a swing of the 10 percentage points from adults with less than a high-school education to those with some university education would have a similar effect. Having gone through the Grade 3 results in some detail, it will now be quicker to go through the Grade 6 results.

There are some small differences between the Grade 3 and Grade 6 results. There are even fewer interaction effects in the Grade 6 results. The inability of the simple model with language, mobility and housing variables to explain the data is even more pronounced. The balanced sample and the full sample now produce virtually identical estimates of the relevant coefficients. And there are some significant changes in the role of the explanatory variables. The lone parent variable continues to reduce scores. The language variable now plays no role in any specification. That is an interesting result. Ontario school boards, in their handling students from a non-official language background, by Grade 6, create a situation where these students have an equal success rate to students who do operate in an official language. The immigration effect is even more pronounced in the Grade 6 data, schools with large numbers of immigrants do better. The immigrant effect is particularly strong in the mathematics assessment. A large proportion of aboriginals in a school community continues to lower average scores. The economic variables continue to matter. Higher average incomes raise scores, higher unemployment rates lower scores. More detached homes raise scores. The one-year mobility variables lowers scores as in the Grade 3 case. It is a little bit interesting that the five year mobility variable has no effect. This is a change from the Grade 3 results. There is also a very interesting change in the effect of parental education. The percentage of the population without a high school diploma no longer has an impact on Grade 6 assessments. The percentage of the adult population with some university education has a very strong impact on achievement results. The coefficient is twice as large as in the Grade 3 case.

The overall ability to explain Grade 6 achievement results is comparable in the Grade 3 and Grade 6 cases. The R^2 is about 28 percent in the models, slightly, but not a lot higher than the equivalent value in Grade 3.

In Table 4-6, a formal test of the equality of coefficients of a variable on the Grade 3 and then on the Grade 6 achievement result is conducted. The model is estimated using Grade 3 and Grade 6 results together. An interaction variable is created as the product of a dummy variable equal to one when the assessment is drawn from the Grade 6 group and the social or economic variable in question. The coefficient on that interaction effect is reported in the second column of Table 4-6. Most of the coefficients on the interaction dummies are not significantly different from zero. This is true for the language variable, the aboriginal variable, the immigration variable, the housing variable, the mobility varalbles and the unemployment rate variable. However, it is not true for the three most important variables, income and the two education measures. This difference means that separate models of Grade 3 and Grade 6 assessments is the appropriate strategy in the interpretation of Grade 3 and Grade 6 achievement results..

4.5 The context variables provided by the EQAO

The EQAO is fully aware of the need to provide context for achievement results. In the results posted on their website for 2000-2001 and 2001-2002, there are either 4 or 5 context variables provided. These are provided by grade rather than by school. The first variable is the percentage of students enrolled in English as a Second Language (ESL) programs. The next variable is the percentage of students receiving special education support. The next two variables are measures of the language spoken at home, either the percentage of students who said they only or mostly speak a language other than English at home or that they speak a language other than English as often as English at home. These are measure of the language context of the student. The final variable can be inferred from the website. Results are reported separately for French immersion students as well as by gender, for ESL and for Special Needs students. Thus it is possible to identify French Immersion schools. We know these schools do draw parents who particularly wish their children to have an opportunity to operate in a second language. This may have an effect of school outcomes, particularly in the absence of any other measures of social and economic characteristics of parents. A sample of 400 schools was created from the website data.[24] However the equation (4.4) can be estimated for the 400 schools and the EQAO set of context variables. The results appear in Table 4.7.

COMMENTS ON TABLE 4.7 and Table 4.7 TO BE ADDED LATER

4.6 Conclusions

There are three conclusions to be drawn from the analysis to this point. First, social and economic variables (as well as dummy variables that control for differences in mean results on assessment) do not explain all the variation in school achievement results. There is residual variation across schools. This means that different schools take students with similar backgrounds and produce different results. Second, although the relationships are very similar between social and economic variables and the achievement results on Grade 3 and 6 tests, they are not identical. It is important to analyze the Grade 3 and 6 results separately. Third, the cheap and easy route to placing the school

[24] The website data is not in machine-readable form. This data had to be entered and checked by hand.

achievement results in context does not work. You really do need a fairly complete set of background variables. In the end, placing the school achievement results in context requires a reasonable effort. It is not an impossible task. But it is a substantial task. In the next chapter, the exemption rate is analyzed. Then in Chapter 6, I return to the achievement data and use the estimated relationships between the achievement data and the social and economic variables to identify outlying schools.

Figure 4-1 Average Achievement by Assessment and Year

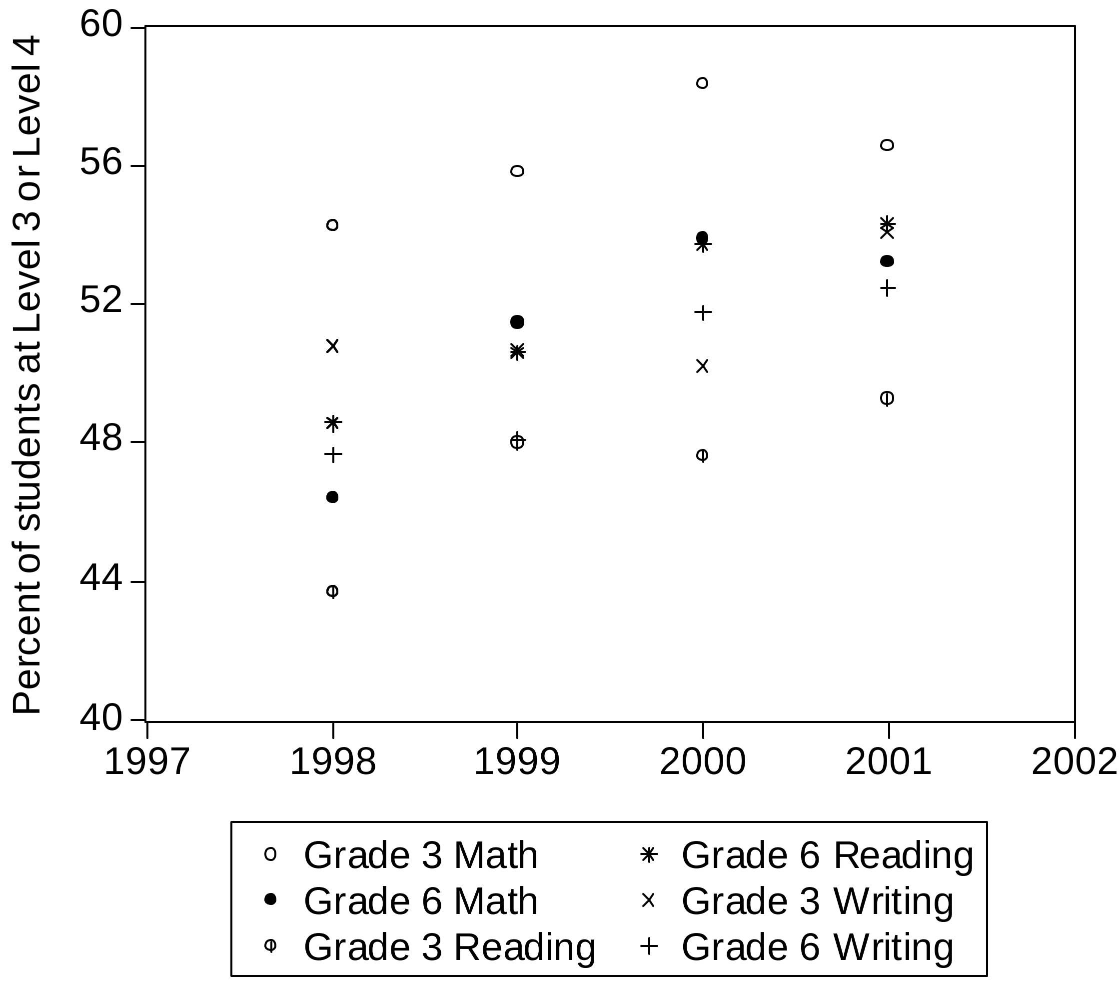

Figure 4-2: The distribution of the Category 1 variable across schools

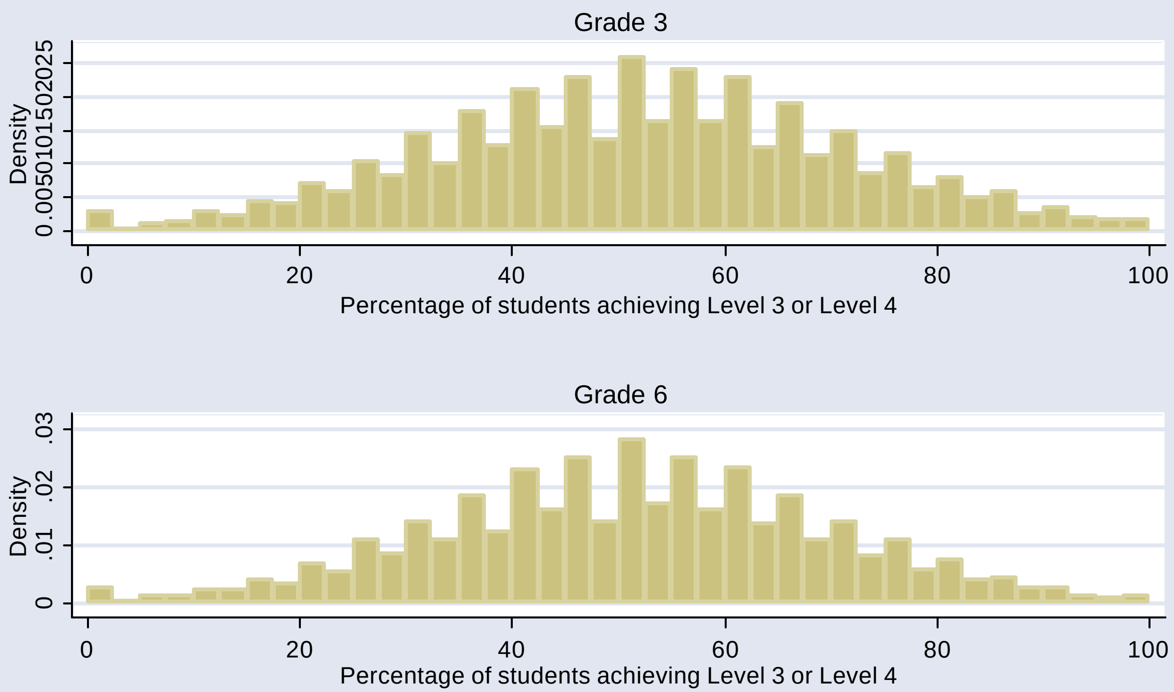

Table 4-1

Percentages of Students in Each Category
(averages across schools)

Academic Year	Number of Schools	Sum at Level 3 and 4 (%)	Sum at Level 1 and 2 (%)	Residual Category (%)	Exemption Rate (%)
1998 - 99					
Grade 3					
Reading	3,548	43.71	46.62	3.07	6.57
Writing	3,548	50.81	41.62	2.59	5.33
Mathematics	3,572	54.27	38.90	1.98	4.84
Grade 6					
Reading	3,339	48.57	44.32	2.59	4.37
Writing	3,343	47.66	44.02	4.19	4.15
Mathematics	3,339	46.41	47.26	1.99	4.19
1999 - 00					
Grade 3					
Reading	3,567	48.00	39.71	5.38	6.90
Writing	3,567	50.68	38.57	4.75	6.00
Mathematics	3,592	55.82	36.37	2.44	5.37
Grade 6					
Reading	3,373	50.61	39.95	4.31	5.13
Writing	3,373	48.09	42.54	4.38	4.99
Mathematics	3,373	51.46	40.16	3.39	4.99

2000 - 2001					
Grade 3					
Reading	3,498	47.67	38.45	8.01	5.97
Writing	3,498	50.20	37.44	7.10	5.32
Mathematics	3,521	58.36	31.57	5.46	4.68
Grade 6					
Reading	3,242	53.73	38.31	4.13	3.92
Writing	3,242	51.76	39.03	5.41	3.86
Mathematics	3,242	53.88	38.31	4.07	3.85
2001 - 02					
Grade 3					
Reading	3,341	49.29	36.25	7.38	5.62
Writing	3,334	54.06	36.16	3.54	5.08
Mathematics	3,370	56.57	31.87	5.57	4.44
Grade 6					
Reading	3,198	54.35	34.34	5.81	4.22
Writing	3,198	52.47	38.77	3.51	4.13
Mathematics	3,200	53.21	35.98	5.43	4.02

Table 4-2

Variation in Achievement Results Across Years
- percentage of students achieving Level 3 or Level 4 -

	Coefficients on dummies[1]			Prob values on tests of equality of coefficients[2]		
	1999-00	2000-01	2001-02			
Column #	(1)	(2)	(3)	(1) to (2)	(2) to (3)	(1) to (3)
Grade 3						
Reading	4.29	3.96	5.57	0.27	0.00	0.00
	(.28)	(.30)	(.33)			
Writing	-0.13	-0.60	3.24	0.10	0.00	0.00
	(.28)	(.30)	(.30)			
Mathematic	1.55	4.09	2.30	0.00	0.00	0.04
	(.32)	(.35)	(.38)			
Grade 6						
Reading	2.03	5.16	5.78	0.00	0.04	0.00
	(.28)	(.31)	(.32)			
Writing	0.42	4.10	4.80	0.00	0.01	0.00
	(.28)	(.31)	(.30)			
Mathematic	5.04	7.47	6.80	0.00	0.05	0.00
	(.32)	(.35)	(.36)			

Notes:
1. Standard errors are in parentheses.
2. The Prob Value at which the null hypothesis that the coefficient in the second column differs from the coefficient in the first column.

Table 4-3

Variation in Achievement Results Across Tests
- percentage of students achieving Level 3 or Level 4 -

Year	Coefficients on Writing Dummy[1]		Coefficients on Mathematics Dummy	
Grade 3				
1998-99	7.10	(.21)	10.55	(.21)
1999-00	2.67	(.18)	7.81	(.21)
2000-01	2.53	(.18)	10.69	(.20)
2001-02	7.77	(.20)	7.28	(.20)
Grade 6				
1998-99	-0.90	(.20)	-2.15	(.20)
1999-00	-2.52	(.19)	0.85	(.19)
2000-01	-1.96	(.19)	0.14	(.21)
2001-02	-1.88	(.18)	-1.13	(.21)

Note:

1. Standard errors are in parentheses.

Table 4-4

The effect of social and economic variables on Grade 3 achievement levels[1]

		Base models		All variables with interaction dummies by type of test			Balanced sample	Scaling Calculation[2]
Variable	Mean (Standard Deviation)	All variables	Three variables	Base coefficient	Interaction with writing	Interactio with math	All variables	(coeff base model X s.d.)
Percent at Level 3 or Level	51.6 (19.0)	-	-	-	-	-	-	-
Percent with lone parents	21.4 (8.9)	-0.12 (.04)	-	-0.13 (.04)	-0.04 (.03)	0.05 (.03)	-0.10 (.04)	-1.07
Percent with an official language	91.0 (10.7)	-0.14 (.04)	-0.30 (.02)	-0.05 (.04)	-0.08 (.02)	-0.17 (.03)	-0.18 (.04)	1.50
Percent of Aboriginal	1.49 (2.8)	-0.61 (.08)	-	-0.59 (.08)	0.09 (.06)	-0.14 (.06)	-0.69 (.10)	-1.71
Percent of one-immigrants	4.8 (6.4)	0.27 (.07)	-	0.23 (.07)	0.05 (.04)	0.05 (.05)	0.24 (.07)	1.73
Percent with detached homes	65.6 (23.6)	0.07 (.01)	0.10 (.01)	0.07 (.01)	-0.01 (.009)	0.03 (.01)	0.06 (.01)	1.65
Income	58,957 (16,227)	-	-	-	-	-	-	-
Log of Income	10.9 (.26)	7.20 (1.64)	-	7.60 (1.69)	0.66 (.91)	-1.86 (.91)	9.05 (1.56)	1.87
Percent moved in last year	14.3 (4.7)	-0.19 (.07)	-0.68 (.06)	-0.19 (.07)	-0.09 (.05)	0.06 (.05)	-0.11 (.08)	-0.89

Variable	Mean (Standard Deviation)	Base models: All variables	Base models: Three variables	All variables with interaction dummies by type of test: Base Coefficient	All variables with interaction dummies by type of test: Interaction with writilng	All variables with interaction dummies by type of test: Interaction with math	Balanced sample: All variables	Scaling Calculation (coeff base model X s.d.)
Percent moved in last 5 years	42.4 (10.4)	-0.11 (.03)	-	-0.12 (.03)	-0.06 (.01)	-0.05 (.02)	-0.15 (.03)	-1.14
Unemployment	8.0 (4.5)	-0.24 (.07)	-	-0.19 (.07)	0.007 (.05)	-0.18 (.05)	-0.3 (.08)	-1.08
Percent without high school	49.0 (9.5)	-0.26 (.06)	-	-0.22 (.06)	0.02 (.03)	-0.12 (.04)	-0.34 (.06)	-2.47
Percent with some university	21.4 (10.5)	0.22 (.05)	-	0.28 (.05)	-0.03 (.03)	-0.12 (.03)	0.11 (.05)	2.31
Total enrolment	345 (162)	0.000 (.000)	-	0.002 (.001)	0.001 (.0007)	0.003 (.009)	-0.001 (.001)	0.00
Sample size	41,113	41,092	41,113	-----------------	41,092	-------------	36,804	-
# of schools		3,582	3,584	-----------------	3,582	------------	3,067	
R-squared	-	0.264	0.11	-----------------	0.266	------------	0.273	-

Notes:

1. Shading indicates the coefficient on that variable is not statistically different from zero.

2. The scaling calculation multiplies the estimated coefficient on a variable by a one-standard deviation increase in that variable.

Table 4-5

The effect of social and economic variables on Grade 6 achievement levels[1]

Variable	Mean (Standard Deviation)	Base models: All	Base models: Three variables	All variables with interaction dummies by type of test: Base coefficient	All variables with interaction dummies by type of test: Interaction with writing	All variables with interaction dummies by type of test: Interaction with math	Balanced sample: All variables	Scaling Calculation[2] (coeff base model X s.d.)
Percent at Level 3 or Level	51 (18.2)	-	-	-	-	-	-	-
Percent with lone parents	21.1 (8.7)	-0.15 (.04)	-	-0.13 (.04)	-0.04 (.02)	-0.01 (.03)	-0.13 (.04)	-1.31
Percent with an official language	91.5 (10.5)	-0.01 (.04)	-0.26 (.03)	-0.001 (.04)	-0.002 (.02)	-0.043 (.03)	-0.02 (.04)	-0.11
Percent of Aboriginal	1.5 (2.6)	-0.61 (.09)	-	-0.62 (.09)	0.08 (.06)	-0.04 (.06)	-0.64 (.11)	-1.59
Percent of one-immigrants	4.5 (6.1)	0.27 (.07)	-	0.20 (.07)	-0.01 (.04)	0.22 (.05)	0.26 (.07)	1.65
Percent with detached homes	66.7 (22.9)	0.06 (.01)	0.07 (.01)	0.05 (.01)	-0.03 (.008)	-0.04 (.01)	0.06 (.01)	1.37
Income	59,086 (16,120)	-	-	-	-	-	-	-
Log of Income	10.95 (.26)	7.41 (1.4)	-	6.58 (1.56)	1.99 (1.13)	0.47 (.89)	6.93 (1.45)	1.92
Percent moved in last year	14.28 (4.6)	-0.22 (.07)	-0.65 (.06)	-0.25 (.07)	-0.02 (.04)	0.11 (.05)	-0.17 (.07)	-1.01

Variable	Mean (Standard Deviation)	Base models: All variables	Base models: Three variables	All variables with interaction dummies by type of test: Base Coefficient	All variables with interaction dummies by type of test: Interaction with writing	All variables with interaction dummies by type of test: Interaction with math	Balanced sample: All variables	Scaling Calculation (coeff base model X s.d.)
Percent moved in last 5 years	42.1 (10.5)	-0.05 (.03)	-	-0.05 (.03)	0.02 (.01)	-0.02 (.02)	-0.08 (.03)	-0.53
Unemployment	7.9 (4.4)	-0.21 (.07)	-	-0.25 (.08)	0.12 (.05)	-0.02 (.05)	-0.26 (.08)	-0.92
Percent without high school	49 (9.5)	-0.04 (.06)	-	-0.06 (.06)	0.01 (.03)	0.04 (.04)	-0.06 (.06)	-0.38
Percent with some university	21.4 (10.5)	0.54 (.05)	-	0.55 (.05)	-0.05 (.03)	0.01 (.03)	0.52 (.05)	5.67
Total enrolment	348 (162)	-0.006 (.001)	-	-0.006 (.001)	0.002 (.0007)	-0.001 (0.0008)	-0.006 (.001)	-0.97
Sample size	31,109	38,753	38,760	-----------------	38,753	------------	34,176	-
# of schools		3,402	3,403	-----------------	3,402	------------	2,848	
R-squared	-	0.288	0.07	-----------------	0.29	------------	0.3	-

Notes:

1. Shading indicates the coefficient on that variable is not statistically different from zero.

2. The scaling calculation multiplies the estimated coefficient on a variable by a one-standard deviation increase in that variable.

Table 4-6

An interaction model of achievement in Grade 3 and Grade 6

Variable	Base coefficient	Interaction with Grade 6
Percent with lone parents	-0.12 (.03)	-0.03 (.04)
Percent with an official language	-0.13 (.04)	0.1 (.04)
Percent of Aboriginal	-0.61 (.08)	0.00 (.09)
Percent of one-year immigrants	0.29 (.06)	-0.03 (.06)
Percent with detached homes	0.07 (.01)	-0.01 (.01)
Income	-	-
Log of Income	8.09 (1.3)	-1.67 (.61)
Percent moved in last year	-0.19 (.07)	0.02 (.08)
Percent moved in last 5 years	-0.11 (.03)	0.05 (.03)
Unemployment Rate	-0.24 (.07)	0.01 (.08)
Percent without high school diploma	-0.24 (.06)	0.18 (.06)
Percent with some university	0.23 (.05)	0.31 (.05)
Total enrolment	-0.0009 (.001)	-0.0005 (.001)
Sample size	79,849	
(number of schools)	3,772	
R-squared	0.27	

Note: A shaded area indicates a coefficient that is not statistically significant.

Chapter 5: An analysis of the exemption process

5-1 Introduction

This chapter contains a short discussion of the exemption process. The EQAO instructions on the administration of assessment state that

> Teachers and principals must make every effort to enable students with special needs to participate with their peers in all aspects of the assessment

AND

> The principal is authorized to exempt a student from part or all of an assessment in a situation where, even with all possible accommodations, the student would be unable to participate productively and/or where the student's participation would be harmful. Before exempting a student, the principal is required to consult with the student's teacher and obtain written parental consent.
>
> (www.eqao.com/eqao/home_page/o5e/5_5e.html)

It is clear that exemptions are not to be granted lightly. While there may be more criteria than stated in the second paragraph above, common sense tells you that it will be very difficult to apply any exemption criteria in an objective way.

The interest in exemptions as part of the interpretation of assessment results comes from two issues. First, an analysis of the exemption data is an indirect examination of the process that creates and administers the assessments. If there is no pattern in exemptions across boards over time, it seems more likely that the assessments are being administered in a consistent way across the province. The criterion for exemptions give no indication of any reason to expect variation across boards. This is a fairly weak test of the consistency of the assessment process and a fairly weak reason to look at exemptions. The second and more important reason to look at exemptions relates to the presentation of assessment results. In presentations of school, board or even the provincial results, assessment results are presented using a Method 2 presentation as well as the Method 1 used in Chapter 4 (in the EQAO terminology). Chapter 4 took note but did not make use of Method 2. Method 2 looks at the percentage of students in the four categories, Level 1, Level 2, Level 3 and Level 4 as a percentage of the non-exempt students. Method 2 is valid only if we have substantial confidence in the exemption process. The conclusion drawn from the analysis below is that it is unlikely that the exemption criteria were applied consistently over time. There is also some evidence, not overwhelming evidence, that the exemption criteria are not applied consistently across boards. This leads one to the conclusion that Method 2 results are not very useful. And indeed, they are not very often used. A more forceful statement would suggest that the EQAO, the schools and the boards simply stop producing and presenting any Method 2 results. They confuse the issue without adding useful information. A third observation could be made. It is slightly more difficult to link exemption rates to social and economic variables than it was to link achievement levels to social and economic variables. It will be more difficult to use statistical techniques to identify schools or boards where exemptions rates are outliers. It needs not be impossible to generate a statistical check on the exemption process, just difficult.

5.2 A broad picture of exemptions over time

A very broad picture of the exemption process is presented in Table 5-1 and Figures 5-1 and 5-2. Table 5-2 presents average exemption rates, calculated over schools, for the 24 assessments in the data. These are then compared across both time and across type of assessment. The null hypothesis that exemption rates have remained constant across the 4 years is strongly rejected.

Although there is no obvious pattern over time in the exemption rates in Figure 5-1, the differences between years are statistically significant. They may not be of much practical significance, the range of variation is quite small. The highest exemption rate is 6.9%, the Grade 3 reading assessment in 1999-00. The lowest exemption rate is 3.84%m the Grade 6 mathematics assessment in 2000-01. In general the exemption rates in Grade 6 are considerably lower than in Grade 3. These are very large samples of both schools and students. It seems very unlikely that the characteristics of the entire pool of Grade 3 students or Grade 6 students would have changed very much from year to year. It seems much more likely that the exemption criteria are applied differently over time. As already pointed out, common sense tells you it will be very difficult to generate consistent exemption criteria.

Table 5-1 and Figure 5-1 also indicate that exemption rates vary by type of assessment. This is a little more mysterious. The criterion seem to be free of any indication that they would vary by type of assessment. The results in Chapter 4 indicate that language issues are particularly important in the determination of results on Grade 3 mathematics assessments. As outsider, like myself to the exemption process, presumes that language is the major exemption issue. This puzzle remains to be solved. It seems noteworthy that in Grade 6, exemption rates are not different across the assessments.

It is reasonable to ask if all of this variation is very important to the interpretation of the elementary school assessment process. In many ways, the answer is likely no. If the primary measure of success is to be the percentage of all students at Level 3 or Level 4, the students who are considered to have mastered the curriculum and if all or virtually all of the exempt students would not have achieved those levels, then variation in the percentage of exempted students is not a critical issue. The interest is indirect. The results suggest above would be completely understandable, that it is very difficult to design and apply an assessment on this scale in a perfectly consistent way. The variation in exemptions lead to using the EQAO data to compare schools with relative measures. This is the exercise in Chapter 6.

5.3 The social and economic determinants of exemptions: Are there board effects?

The method of analysis used in the previous chapter to consider variation in achievement results can be used to measure (1) the social and economic determinants of exemption rates and (2) whether there are effects of school boards on exemption rates. It is interesting to know if there are such board effects. All boards would get the same instructions from the EQAO. Principals at boards would interact to interpret these instructions. It would be very likely that similar decisions might be made at the board level by a “group” of principals. The analysis is used to look for such effects.

The equation estimated is

$$EX_{,i,t} = a + d_{Board} D_{Board} + ß^1_X X^1_i + ß^2_X X^2_i + u_{,i,t} \qquad (5\text{-}1)$$

where the sample is the 3500 schools and D_{board} is a dummy or indicator variable for a board. X^1 and X^2 represent the same list of social and economic indicators by school used in Chapter 5.

Table 5-2 is a list of boards not included in this analysis. To estimate a group effect on exemptions, there needs to be enough members of the group to generate a statistical effeect. Table 5-2 lists all boards in the data set that have less than 10 schools. This left 64 boards in the sample.

Table 5-3 is the set of results from estimating equation (5-1) for the sample of schools. There are some econometric (statistical) issues in its estimation. Figure 5-2 shows that the distribution of exemptions is very highly skewed to the right, a few schools have very high exemption rates. The exemption rate cannot, as is true for many variables in the analysis, go below zero. However there are a significant number of schools (131) where the exemption rate is exactly zero even averaged over the four years. All of this creates problems for the analysis. Table 5-3, to be consistent with the rest of the analysis, presents OLS estimates of the exemption equation. The same list of social and economic factors are used. However the equation is not as successful as the equivalent equation explaining variation in school achievement results. The R^2 is much lower. Many of the social and economic variables are not significant. Lone parenthood does not affect exemptions. Exemptions do fall when there are more persons in the school community who do not speak and official language. Exemptions rise in Grade 3 when there are more aboriginal students but there is no such effect in Grade 6. There are fewer exemptions when there are more recent immigrants. This is consistent with the result that, after controlling for other variables, recent immigrants have higher achievement levels. There are fewer exemptions when there are more detached homes. Again the effect in Grade 6 effect is weaker. Exemptions rise when students have moved in the last year but not in the last five years. Exemptions rise with unemployment rates and fall with income. None of these results are surprising. The coefficients on the parental education variables are a bit surprising. Educational status of parents does not matter in Grade 6. In Grade 3, more educated parents apparently increase exemption rates. That is a bit of a puzzle. The effect is reversed but not significant in Grade 6. Smaller schools have slightly lower exemption rates but the effect is very small.

The equation above was estimated using Ordinary Least Squares. Because of the distribution of the exemption rates, this may not be the most desirable estimator to use. The equation were re-estimated using both a Tobit model to account for the truncation of observations at zero and with a transformation of the dependent variable by taking its natural logarithm.[25] However, as a way of measuring board effects, I do use all three models. Looking for board effects on exemption rates is a very interesting exercise. It was carried out by adding board dummy variables to the base equation. 64 boards are included. The last row of Table 5-3 reports the number of board dummies that are statiscally different from zero. Such coefficients mean that in these boards, for the same social and economic variables, exemption behaviour that was systematically different that the exemption behaviour of schools in the base board. The base case board was the Waterloo Regional District School Board. This is a medium sized board with a wide variety of schools - both rural and urban - both rich and poor. Table 5-3 is some evidence of board-level variation in the application of exemption criteria. Depending on the model, about one-third of the boards behave differently than the Waterloo board. In many cases they also behave differently from each other. However the variation by board in exemption rates is not that large, only from 2.5 to 11.5 percent. The variation in exemption rates across schools is much larger as shown in Figure 5-2 and mostly unexplained by known social and economic variables.

5-4 Conclusions

This chapter promised a short analysis of the exemption rates. There is some evidence that these rates do vary over time and do vary across boards in ways not fully explained by social and economic variables. This is not surprising. The impact on the main use of EQAO assessments is quite limited. None of the analysis in the previous chapter depended on a consistent application of the exemption criteria. Such a consistent analysis may not be possible. The main policy implication is to

[25] I do not bother to include coefficient estimates for these versions. They are not very different. Transformation of exemptions rates by taking logarithms drops the schools with exactly zero exemption rates from the data.

direct attention away from Method 2 results in all circumstances. Method 2 results are clearly open to manipulation if the exemption criteria are applied in an inconsistent way. Method 2 should not be used or presented.

Figure 5-1 Average Exemption Rates by Assessment and Year

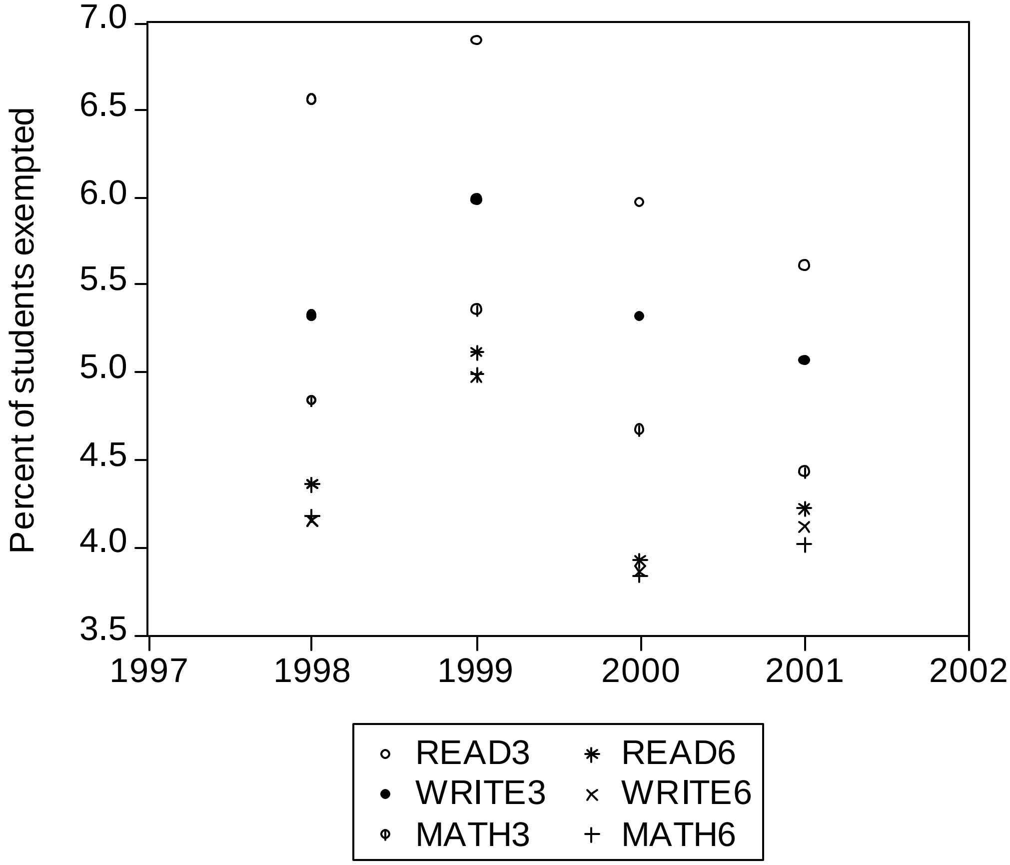

Figure 5-2: Percentage of students exempted from assessments by school

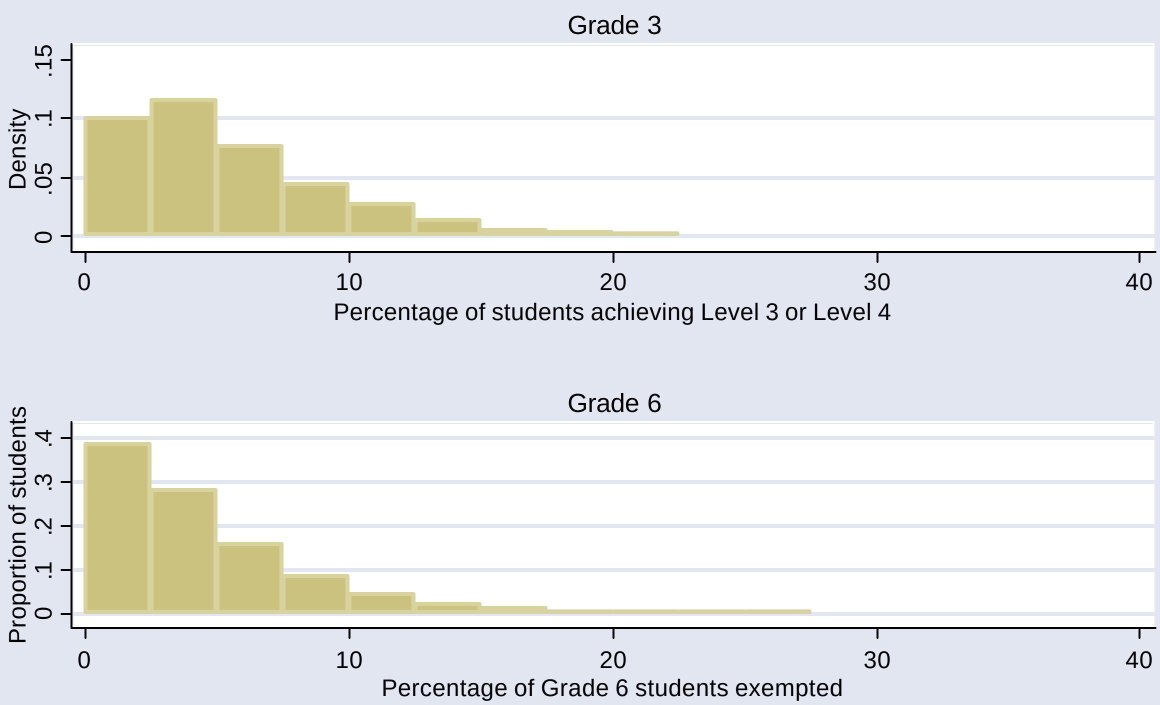

Table 5-1

The Exemption Process

Average Exemption Rate	Year 1998-99	1999-00	2000-01	2001-02	Null hypothesis tested: equality of exemption rates across years (Prob Value)
Grade 3					
Reading	6.56	6.90	5.97	5.61	0.00
Writing	5.33	5.99	5.32	5.07	0.00
Mathematics	4.84	5.36	4.68	4.43	0.00
Null hypothesis tested: equality of exemption rates across tests (Prob Value)	0.00	0.00	0.00	0.00	-
Grade 6					
Reading	4.36	5.12	3.92	4.22	0.00
Writing	4.15	4.98	3.86	4.12	0.00
Mathematics	4.18	4.99	3.84	4.01	0.00
Null hypothesis tested: equality of exemption rates across tests (Prob Value)	0.46	0.71	0.90	0.47	-

Table 5-2

Boards not included in the analyses of exemptions

Board	Number of Schools
Trenton CFB	1
Connell and Ponsford	1
Atikokan Catholic	1
Northern District School Area Board	2
Kenora Catholic	4
Conseil Scolaire de district Nord-Est	5
Northwest Catholic	5
Conseil Scolaire de district Catholique des Aurores Boreales	7
Superior North Catholic	9
Conseil Scolaire du Grand Nord	10
Superior Greenstone	10

Table 5-3

Social and Economic Determinants of Exemption Rates

Variable	Grade 3 coefficients (standard error)[1] without board dummies	Grade 3 coefficients (standard error)[1] with board dummies	Grade 6 coefficients (standard error) without board dummies	Grade 6 coefficients (standard error) with board dummies
Percent with lone parents	0.01 (.01)	0.007 (.01)	0.01 (.01)	0.001 (.01)
Percent with an official language	-0.08 (.01)*	-0.06 (.01)*	-0.05 (.02)*	-0.02 (.02)
Percent of Aboriginal	0.11 (.04)*	0.15 (.06)*	0.03 (.04)	0.02 (.04)
Percent of one-year immigrants	-0.1 (.03)*	-0.09 (.00)*	-0.03 (.03)	-0.04 (.03)
Percent with detached homes	-0.02 (.006)*	-0.02 (.006)*	-0.01 (.006)*	-0.017 (.006)
Log of Income	-3.43 (.62)*	-3.34 (.74)*	-2.25 (.62)*	-2.82 (.74)
Percent moved in last year	0.06 (.02)*	0.09 (.02)*	0.035 (.027)	0.07 (.02)*
Percent moved in last 5 years	-0.005 (.01)	-0.01 (.01)	0.007 (.10)	-0.005 (.01)
Unemployment Rate	0.09 (.03)*	0.06 (.03)*	0.08 (.03)*	0.07 (.03)*
Percent without high school diploma	0.02 (.02)	0.07 (.02)*	-0.02 (.02)	-0.002 (.02)
Percent with some university	0.04 (.02)*	0.06 (.02)*	-0.03 (.02)	-0.02 (.02)
Total enrolment	-.000 (.000)	-0.001 (.0005)*	-0.001 (.0004)*	0.001 (.0003)
R-squared	0.18	0.27	0.14	0.23
Number of board dummies significantlly different from zero[2]	OLS	19/64	OLS	23/64
	Tobit	21/64	Tobit	19/64
	Log	16/64	Log	14/64

Notes:

1. The standard errors marked with an asterisk (*) mean that the coefficients of the variables are significantly different from zero at 95% confidence level.
2. There are 63 coefficients estimated on board dummy variables. The first value counts the number of dummy variables significantly different from zero, that is, with exemption behaviour significantly different from the base board. The base board is the Waterloo Region District School Board.