Enclaves, peer effects and student learning outcomes in British Columbia[1]

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Abstract

We use data on elementary-school students in British Columbia to investigate how the home language and other characteristics of a student's same-grade schoolmates influence that student's academic achievement. We exploit the availability of multiple cohorts of data within each school to control for endogenous selection by incorporating school-grade-subject fixed effects in the model. We also exploit the longitudinal structure of the data to estimate value-added models of the educational production function. We find that the attending an "enclave" school provides a slight net benefit to Chinese home-language students and a large net cost to Punjabi home-language students. The results are consistent with a simple model of peer effects in which the academic achievement of peers is much more important than their home language.

JEL Codes: J10, J15, I21.
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1 Introduction

The marked tendency for immigrants to settle in local enclaves in host cities may have significant consequences for their economic success and ultimate integration into their new country (Borjas 1992, 1995, 2000; Edin, Fredriksson and Åslund 2003). Whether these consequences are beneficial or harmful is a matter of extensive debate in the literature. On one hand, enclave concentration may be costly for immigrants by reducing the rate at which they adapt to host country culture and acquire host-country-specific skills such as language proficiency (Chiswick and Miller 2002), and may worsen discriminatory attitudes and practices towards immigrants among non-immigrants (Dustmann and Preston 2001). On the other hand, enclaves may benefit immigrants by insulating them from discrimination and providing opportunities for within-group networking (Portes 1987, 1995; Lazear 1999; Bertrand, Luttmer and Mullainathan 2000). The net effect is clearly an empirical question and one that may vary by context.

One important consequence of enclave neighborhoods is that they tend to produce enclave schools. Recent evidence supporting the importance of school-level peer effects (see Hanushek et al. 2004 for a partial review) motivates us to investigate the importance of schools as specific institutions through which immigrant enclaves may affect individual outcomes. Schools play a particularly important role in the social and economic integration of immigrant children by providing opportunities for language acquisition and adaptation to the host culture, as well as by offering skills and credentials needed for economic success. The ambiguous implications of enclave formation for immigrant success in other arenas are mirrored within schools. On one hand, the tendency for immigrants to concentrate in enclaves may hinder students if language acquisition rates are slower and student learning outcomes are adversely affected when the share of immigrant students in the classroom is high. On the other hand, social and support networks among immigrant children may be stronger in schools that are concentrated by home language, leading to better academic outcomes. Moreover, the consequences of enclave formation may extend beyond the immigrants themselves: the presence of significant numbers of newcomers may affect the learning environment of native-born students and earlier immigrants who have already largely adapted to life in the host country. While several studies document the concentration of immigrants within schools and characterize the dynamics leading to this concentration (e.g., Gould, Lavy, and Paserman 2004; Betts and Fairlie 2003), few have looked directly at the effect of immigrant concentration on the school outcomes of immigrant children themselves.

This paper begins to address this gap in the empirical literature by examining the spillover effects on learning outcomes associated with the presence at British Columbia (B.C.) schools of students whose families are not linguistically assimilated with respect to the language of instruction. We measure the degree of linguistic assimilation using two variables: the language spoken in a student's home and whether the student is designated to receive English as a Second Language (ESL) services. More specifically, we estimate the influence of the percentage of same-grade schoolmates who report speaking different home languages and the percentage who receive ESL services on a given student's academic achievement. This influence is allowed to differ according to the student's own home language and ESL status. Achievement is measured by the net change in standardized test scores between grades 4 and 7. We address endogenous selection into schools by using multiple cohorts of students and thus allowing for school-by-grade level fixed effects.

We find some evidence for substantial peer effects as well as evidence that peer effects play a role in explaining achievement differences across B.C.'s major home-language groups (English, Chinese, and Punjabi). The proportion of Chinese home-language peers has a weak positive association with achievement, and the proportion of Punjabi home-language peers has a strong negative association with achievement. As a result enclaves provide minor benefits to Chinese home-language students and major costs to Punjabi home-language students. These findings are robust to a number of alternative specifications of our econometric model.

1.1 Related Literature

Research on peer effects in education dates back to the late 1960's "Coleman Report" (Coleman et al. 1966). Early research on peer effects was plagued with identification problems due to endogenous assignment of students to schools and/or classrooms (Manski 1993). Work since the late 1990's has attempted to address these problems with varying degrees of success. The most commonly-used research design in this recent literature (e.g., Hoxby 2000; Hanushek et al. 2002, 2003, 2004; Betts and Zau 2004; Figlio 2007; Cooley 2007a; as well as this paper) uses large multi-year administrative data sets along with whatever fixed effects (for schools, students, and/or teachers) the data allow. Other work uses data from experiments, whether in the form of random assignment of students to schools and/or classrooms (e.g., Hoxby and Weingarth 2007; Ding and Lehrer 2007) or in the form of random assignment of outcome-relevant treatments to individual students (e.g., Boozer and Cacciola 2001; Graham 2008).

The empirical evidence at this point is not conclusive, but generally supports the proposition that there are peer effects in academic achievement. Hoxby (2000), Hanushek et al. (2003), Boozer and Cacciola (2001), Betts and Zau (2004), Ding and Lehrer (2007), and Graham (2008) all find that student achievement is increasing in the achievement of one's peers. However, a number of these studies produce implausibly high estimates of the peer effect, and Vigdor and Nechyba (2007) find evidence this relationship is an artifact of endogenous selection rather than a true peer effect. Peer background characteristics such as race, gender, and parental education or socioeconomic status also appear to have some association with achievement. For example, Hoxby (2000) finds that test scores are affected by the racial and gender composition of the student's peer group. Hanushek, Kain and Rivkin (2004) find strong adverse effects on the test scores of lower achieving blacks associated with a higher percentage of black schoolmates. However, Cooley (2007b) notes several examples in the literature in which a larger proportion of black peers is positively associated with exam scores. Cooley argues that these conflicting results, along with some of the more counterintuitive results seen in the literature, can be resolved by considering all peer group composition variables (including those based on test scores) as proxy variables for ability and effort. While ability is often modeled using student fixed effects or lagged test scores, studies with direct evidence on student effort or behavior are rare. One exception is Figlio (2007), who finds evidence that disruptive students have a negative impact on their peers' achievement. Complicating the picture further, several studies (e.g. Angrist and Lang 2004; Hoxby and Weingarth 2007; Cooley 2007a) have found evidence that peer effects vary systematically with one's own characteristics.

There is also a sizeable literature on immigrant residential enclaves and the formation of human capital. The econometric literature is often based on census data, and its most commonly analyzed outcomes are wages or earnings (Borjas 1995; Edin, Fredriksson, and Åslund 2003), educational attainment (Borjas 1995, 1998), and self-assessed language acquisition (Chiswick and Miller 2002). This study approaches the issue in a distinct but complementary manner by investigating the effect of enclave schools on test scores. The current evidence in the literature is that enclaves matter, though not always in a simple way. Edin, Fredriksson, and Åslund (2003), using Swedish data, find that enclaves provide a substantial earnings benefit to low-skilled immigrants. Borjas (1995) finds a negative effect of enclaves on the educational attainment of immigrants in the U.S., while Borjas (1998) finds that this effect depends on the average educational attainment within one's own ethno-cultural group. Chiswick and Miller (2002) find a negative effect of enclaves on English proficiency among immigrants to the U.S. Friesen and Krauth (2007) find that in the Canadian province of Alberta a higher rate of student sorting by home language across schools within a community is associated with increased community-level variance in test scores. This result suggests that there are peer effects related to the home language of peers. Evidence on the effect of immigrant peers on outcomes for native-born students is mixed. Gould, Lavy, and Paserman (2004) find that drop-out rates and the quality of high schools attended by non-immigrants were unaffected by large immigrant inflows into Israel. Betts and Fairlie (2003) find that parents of secondary school students in the U.S. often move their children to private school in response to inflows of immigrants to the local public school, but parents of primary school students do not.

2 Data and Institutional Background

2.1 Funding and organization of the B.C. school system

British Columbia is Canada's third largest province, with a 2001 population of just over 4 million, about half of whom live in Vancouver or its suburbs. Elementary schools in B.C. typically provide Kindergarten through grade 7, with secondary schools offering grades 8 through 12. Approximately 690,000 students were enrolled in Kindergarten through Grade 12 (K-12) education in 2001 (B.C. Ministry of Education 2005).

About 90 percent of K-12 students in B.C. attend public schools. Among the remaining 10 percent, the overwhelming majority of students attend religious or secular private schools that receive public funding and substantial government oversight, and a very small number of students are home-schooled or attend private schools that do not receive government funding. Within the public system, school choice is primarily determined by residential location within catchment areas set by each district. However, there are several alternatives to the local school. About 6 percent of students are enrolled in public school French Immersion magnet programs, which developed across Canada in the 1970's as part of a national effort to encourage bilingualism. A small Francophone public school system, part of the provincial system but administered as a separate district, offers instruction in French to students whose first language is French. Some districts also operate small alternative schools and magnet programs that specialize in academics, fine arts, or athletics. Finally, a student can sometimes enroll in a public school outside his or her catchment area. In 2003, the provincial government instituted an official "open boundaries" policy that allows any student in B.C. to attend any public school if there are spaces available after local students have enrolled. Previously, individual districts had discretion on whether a student could register out of his or her catchment area.

Education in Canada falls under provincial jurisdiction, with on-reserve Aboriginal education being an important exception. Funding and curriculum are both set by the provincial Ministry of Education. The Ministry provides operating and capital grants to the district public school boards, who then allocate funds to individual schools. These grants are the main funding source for public schools. With a few exceptions, private schools also receive per-student operating grants of 35-50% of the base public school rate, and are responsible for teaching the provincial curriculum and meeting various provincial administrative requirements. The funding formula for operating grants to public school districts is described in Table 1. As the table shows, funding is based primarily on total district-level enrollment, with supplementary funding based on the number of Aboriginal students, the number of students enrolled in programs for English as a Second Language (ESL), and the number of special needs students.

All districts that receive supplementary funding for ESL, Aboriginal, and special needs students are required to demonstrate to the province that they are delivering specific services to address these students' particular needs. Funding for Aboriginal students and some categories of special needs students is targeted, meaning the funds must be used only to provide services to these students. In contrast, supplementary funding for ESL students and other categories of special needs students can be spent at the discretion of the district, as long as some form of special services are provided for these groups. Districts receive ESL funding only for students who have been designated ESL for five years or less. In addition to these provincial program funds, the Federal government provides supplemental funds to school districts in support of French Immersion programs.

Careful interpretation of ESL status in our data must take into account two institutional details. The first relevant detail is the five-year time limit described above. The second is that the administrative category of ESL in B.C. encompasses two distinct groups: traditional ESL students and "English as a Second Dialect" (ESD) students. An ESD student is one whose first language is English but whose early-childhood exposure to Standard English was very limited. Such students face some of the same issues as traditional ESL students, and require similar support services. As a result, districts may count them as ESL students for funding purposes. In B.C. the ESD concept has been implemented extensively in some districts and not at all in others, and has been applied almost exclusively to Aboriginal students (Friesen and Krauth 2008).

2.2 The Foundation Skills Assessment (FSA) tests

The B.C. Ministry of Education administers a set of standardized tests known as the Foundation Skills Assessment (FSA) in May of each year to students in grades 4 and 7 in all public and provincially funded private schools in British Columbia. FSA testing began in the 1999/2000 school year[2] and is based on a variety of questions divided into the subject areas of Reading Comprehension, Numeracy, and Writing. The Reading and Numeracy exams include both multiple-choice and open-ended questions, while the Writing exam includes one short writing task and one long writing task. All exams are graded by accredited B.C. teachers in a central location. All students are expected to participate in the FSA tests, with the exception of ESL students who have not yet developed sufficient English language skills to respond to the test, and some special needs students.

The FSA exams are relatively low-stakes for all parties. Students' scores do not contribute to their school grade and play no role in grade completion. The results do not affect school or district funding. However, school and district-level results are available to the public[3] and are extensively discussed within both the educational system and the news media. In particular, a widely-publicized annual "report card" produced by the Fraser Institute (e.g., Cowley and Easton 2005) ranks all B.C. elementary schools primarily on the basis of FSA results.

2.3 Data description

The underlying administrative data used in this study are drawn from the Ministry's enrollment database and its FSA exam database. Each student's unique identification code is used to construct a longitudinal record across multiple years of the enrollment and FSA exam databases. Records in the enrollment database are based on Form 1701, the annual enrollment form collected for each student on September 30 of each year. These forms are used by the Ministry to determine funding in accordance with the funding formulas described earlier. The enrollment record includes the student's current grade, school and district identifiers, year, gender, self-reported Aboriginal status, enrollment in a language program (e.g., ESL, French Immersion, Francophone education), enrollment in a special needs program, and self-reported language spoken at home. Records in the FSA exam database include the student's score on each exam subject, along with a flag indicating whether the student was excused from writing a given exam.

Our analysis is based primarily on a longitudinal data set constructed from an extract[4] of

[2] FSA tests were also administered to grade 10 students between 2000 and 2004; these low-stakes assessments were replaced by high-stakes Provincial examinations beginning in 2005.
[3] District- and school-level result reports can be obtained from the Ministry's website.
[4] Because of confidentiality restrictions, our extract differs from the original administrative data in the following ways: (1) enrollment records are provided only for students in grades 4 through 7; (2) student,

this administrative data. The extract includes every student who is in grade 7 in B.C. during the school years 2002/2003 through 2004/2005, and who is in grade 4 in B.C. in the 1999/2000 school year or later. That is, there are three cohorts of grade 7 students who also have grade 4 FSA results. Wherever such information exists, the longitudinal record also includes information from the student's enrollment records in grades 5 and 6.[5] The data include both public and private school students, but does not include students in the Francophone system. A student's peer group is defined as all students attending the same grade in the same school in the same year. We treat French Immersion and regular program students as attending different schools, even if housed in the same school building. French Immersion students receive instruction mostly in French, and do not attend classes with and rarely participate in organized activities with regular program students.

3 Descriptive Statistics

3.1 The B.C. student population

Table 2 provides descriptive statistics for the population of non-Aboriginal students that were enrolled in a B.C. public or private school in grade 7 between 2002 and 2004. Because the issues associated with Aboriginal education in B.C. are somewhat complex and beyond the scope of this analysis, we restrict attention to the non-Aboriginal population throughout this paper. A separate paper (Friesen and Krauth 2008) addresses educational outcomes among Aboriginal students.

The statistics in Table 2 are reported for the entire population, as well as broken down by home language. As the table shows, B.C.'s student population is moderately heterogeneous, with about 21% of students speaking a language other than English at home. The most common category of non-English home languages is Chinese, spoken by 7% of students, followed by Punjabi, spoken by almost 4% of students. Another 10% of students report speaking a different non-English home language. Within this group, the most frequently reported languages are Korean, Tagalog/Philipino, Vietnamese, Spanish, and Hindi. Fewer than 2% of students report speaking any one of these languages and all of these languages are grouped together under "Other" in our data set.

Rates of participation in special education vary substantially by home language. Students

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school, and district identification codes are encrypted in such a manner as to allow for within-database linkage, but not linkage with external information; (3) language spoken at home is aggregated from the over 100 languages in the administrative data into English, Chinese (including Cantonese and Mandarin), Punjabi, and Other; and (4) both language spoken at home and Aboriginal status are provided based on the student's entire history rather than on the current year's self-report. In particular a student is categorized as Aboriginal if he/she ever self-reports as Aboriginal. A student is categorized as speaking English if he/she always self-reports as English, and is otherwise categorized by his/her most frequently reported home language other than English.

[5] A minority of students who are observed in both grades 4 and 7 during the FSA exam period either repeat grades, skip grades, or are out of province for one or more of the intervening years. We keep these students in our analysis whenever possible. If the student repeats either grade 4 or grade 7, the longitudinal record is constructed from the student's last year in grade 4 and first year in grade 7.

with a home language other than English are about half as likely as English home-language students to be recognized as disabled.

Although 21% of grade 7 students speak a language other than English at home, fewer than 6% are classified as ESL. This is primarily due to the Ministry's policy of funding only 5 years of ESL programming per student: over 13% of these same students were in ESL in grade 4, and over 21% were in ESL at some point in their schooling. As discussed earlier, ESL status in grade 7 is to some extent a proxy for being in the province for less than 5 years.

The remaining rows of Table 2 describe the peer group composition of the average student in each language category. The peer group is defined as one's same-grade schoolmates and includes both Aboriginal and non-Aboriginal schoolmates. As the table shows, English home-language students are somewhat more likely than other students to have a substantial number of Aboriginal peers. Surprisingly, although measured disability rates vary substantially by home language, there is very little variation in the proportion of peers who are categorized as disabled.

As the table shows there is a substantial degree of sorting on home language in B.C. The typical English home-language student attends a school in which students speaking English at home form a sizeable majority (about 88%). On the other hand, the typical Chinese home-language student attends a school in which only 44% of the students speak English at home, and about 34% speak Chinese at home. The typical Punjabi home-language student attends a school in which about 50% of students are English-speakers and about 29% of students speak Punjabi at home. As one might expect, students speaking a home language other than English also have more peers in traditional[6] ESL programs.

3.2 FSA participation and outcomes

Next we describe results on the Numeracy and Reading FSA exams. The Writing exam results are not suitable for this study – nearly all students receive the same score – and so are not included.

Tables 3 and 4 describe the patterns of participation in the FSA exams. Unlike many U.S. jurisdictions, B.C. has not implemented accountability rules that lead to large numbers of students being exempted from standardized testing. About 91% of grade 7 students in B.C. take exams, compared to, for example, about 82% in Texas (Hanushek et al. 2002). Participation rates are important in assessing exam results, as researchers have

[6] We separate the ESL administrative category into ESD and "traditional" ESL. Since almost all Aboriginal students would be Canadian-born, Aboriginal English-home-language students in ESL can be safely inferred to be ESD. ESL students who speak a language other than English at home can be safely inferred to be traditional ESL students. The small population of non-Aboriginal English-home-language students in ESL includes a mix of ESD and traditional ESL students. For the purposes of this study, ESL students who are Aboriginal and speak English at home are categorized as ESD. All other ESL students are categorized as traditional ESL.

found that schools often respond to exam-based accountability measures by discouraging the participation of students likely to do poorly (Figlio and Getzler 2002; Jacob 2005).

Table 3 indicates that Punjabi home language students are slightly more likely to participate in the exams than English home-language students, with Chinese and other home-language students slightly less likely. Speakers of non-English home languages are generally more likely to be excused from the exams. Table 4 indicates that participation has been fairly stable over the period of our data, although it has trended slowly downward, and a higher-than-usual proportion of students were excused in 2001.

Table 5 reports exam outcomes by home language, both in terms of levels and in terms of gains. Test scores have been standardized within each subject-year-grade to have a zero mean and unit variance, so the units reported in Table 5 can be interpreted directly as standard deviations. As the table shows, Chinese home language students earn substantially higher grades than other groups, and truly excel in numeracy. Punjabi home language students score substantially lower than average on both exams. Students speaking other non-English languages score somewhat below average in reading, and slightly above average in numeracy.

When we look at test score gains, the picture is somewhat different. All three non-English home-language groups improve relative to English home-language students between grades 4 and 7 in both reading and numeracy. Although Punjabi home-language students do substantially worse than English home-language students in grade 7, the gap between Punjabi and English home-language student narrows somewhat between grade 4 and grade 7.

One may be concerned that patterns in test scores may be artifacts of differential participation rates, so we also consider a simple binary measure of progress that includes nonparticipation as an outcome. We report the “% showing progress” for each exam, where “progress” is defined as follows. A student who takes the exam in both grades is classified as showing progress if his or her test score improves. A student who takes the exam in grade 4 but not in grade 7 (and is in the data for both grades) is classified as not showing progress, while a student who takes the exam in grade 7 but not grade 4 (and is in the data for both grades) is classified as showing progress. A student who is out of province for one of the two grades, or who takes the exam in neither grade, is excluded. As the table shows, students speaking a language other than English at home are substantially more likely than average to show progress on both exams.

4 Methodology

4.1 Model specification and research design

Our overall empirical strategy for measuring peer effects is based on a panel-data extension to the standard linear-in-means model of contextual peer effects (Manski 1993). As is now well known, peer effects are in general not identified from crosssectional data whenever the assignment of individuals to groups is nonrandom. Whether through private schooling or housing markets, family income and education influence the quality of a child's school. Either of these factors will lead to nonzero correlation between peer group composition and unobserved school or student factors relevant to educational outcomes.

Our research design uses individual student-level panel data from multiple cohorts of students within each school, and exploits the small but plausibly random year-to-year variation in peer group composition within a school to consistently estimate school-by-grade level peer effects, while allowing for systematic cross-school variation in school or student quality via school fixed effects. Variations on this design are quite common in the recent literature on educational peer effects (e.g., Hoxby 2000; Hanushek et al. 2002, 2003, 2004; Betts and Zau 2004; Figlio 2007; Cooley 2007a). The appropriateness of this methodology depends critically on the extent to which the year-to-year variation within schools is due to random fluctuations (i.e. the composition of any year cohort represents a finite sample drawn from the underlying population of families) rather than due to specific long-term trends (for example a gentrifying neighborhood, or the introduction of new programs in a school that draw high-achieving students from outside the school's catchment area).

The education production function – the relationship between cumulative inputs and current test score – is assumed to follow the simple value-added (SVA) model (Todd and Wolpin 2005). In the SVA model, a given test score is a sufficient statistic for the effect of all relevant prior inputs on educational achievement, and past inputs enter into current performance with no "decay." Given these two strong assumptions, the contribution of current inputs to the test score can be estimated by a reduced-form regression of the test score gain on the current inputs.

The model is constructed as follows. Students are indexed by $i=1,2,\dots,n$; schools by $s=1,2,\dots,S$; grades by $g=4,7$; and time by $t=1,2,\dots,T$. Let $y_{i,g}$ be the score of student i in grade g. Let $t(i,g)$ be the school year in which the student takes grade g, and let $s(i,g)$ be the school student i attends in grade g. Let $X_{i,g}$ be a vector of student i's individual background characteristics in grade g, and let the vector $\bar{X}_{i,g}$ be the average value of X among student i's same-grade schoolmates in grade g. Peer effects in our model will be allowed to vary by one's own characteristics so that, for example, the effect of Punjabi home-language classmates may vary by one's own home language. This will be incorporated into the model as a vector of dummy variables $D(X_{i,g})$ that will be interacted with $\bar{X}_{i,g}$. Then let the model be:

$$y_{i,7} - y_{i,4} = \beta X_{i,7} + \lambda D(X_{i,7})\bar{X}_{i,7} + \delta_{t(i,7)} + a_{s(i,7)} + v_{s(i,7),t(i,7)} + u_{i,t(i,7)} \qquad (1)$$

where β and λ are vectors of parameters to be estimated, δ_t is an unobserved year-specific fixed effect, a_s is an unobserved school-specific fixed effect, $v_{s,t}$ is an unobserved school-and-year-specific effect and $u_{i,t}$ is an unobserved individual-and-year-specific effect. The identifying exogeneity assumption is:

$$E\left(\varepsilon_{s(i,7),t(i,7)} + u_{i,t(i,7)} \middle| X_{i,7}, \bar{X}_{i,7}, \delta_{t(i,7)}, a_{s(i,7)}\right) = 0 \tag{2}$$

That is, anything specific to a particular individual and school in a particular year is exogenous. Given these assumptions, the structural parameters β and λ are consistently estimated using the standard linear fixed effects estimator.

The content of our identifying assumption is similar to that in the related literature; while the overall composition of a school may be systematically related to unobserved school and student characteristics, the small cohort-to-cohort fluctuations in composition within a school may be considered essentially random within a short period of time and thus unrelated to cohort-to-cohort fluctuations in other unobserved factors. Note that we allow for within-group common shocks like, for example, an instructor being replaced with a lower-skilled substitute while on parental leave, provided these shocks are unrelated (in conditional mean) to the observed composition of the group.

A further complication in interpreting our regression coefficients as parameters of a cumulative-input education production function is introduced by the fact that there is a three-year gap between exams rather than a one-year gap as in the Texas data. Our main regressions only include measures of grade 7 inputs, including both peer characteristics and the school fixed effect. With unlimited data it would be preferable to include grade 5 and 6 inputs as well, including grade-specific school fixed effects. As such an approach would rapidly exhaust degrees of freedom in our regressions, we prefer to estimate models with grade 7 inputs only. These results should be interpreted with the caveat that grade 7 peer characteristics are also acting as a proxy for grade 5 and 6 peer characteristics.[7] We estimate models with grade 5 and 6 characteristics as robustness checks.

4.2 Population under analysis and choice of explanatory variables

The population in our regression analysis is B.C. public and private school students who attended grade 7 between 2002/2003 and 2004/2005, and who attended grade 4 in B.C. in 1999/2000 or later. All specifications are estimated from the population of non-Aboriginal students who take a given exam, while the school-grade compositional variables are based on the entire population of enrolled students, including both Aboriginal students and students who do not take the exam. The special issues faced by Aboriginal students in B.C. imply that both the school fixed effect and the peer effects may vary between Aboriginal and non-Aboriginal students. Rather than explicitly incorporating an even larger number of interaction terms into the model, we address this by estimating the model for non-Aboriginal students only.

Our main results, to be reported in Table 6 and discussed in Section 5.1, are based on four

[7] Note that this issue would still be present (though to a substantially lesser degree) in data with annual testing: students change schools during the year, and the peer group measured on a particular day during the year is used as a proxy for the peer group during the year as a whole.

specifications of the model. These specifications vary in terms of whether the effect of peer home language varies by one's own home language, and in terms of whether ESL status and peer ESL status are included as explanatory variables. A number of previous peer effect studies have found evidence that students with different characteristics respond differently to peers, and heterogeneity in response is particularly relevant to enclave formation.

In interpreting the results from any of these specifications, it is important to understand the role of the home language variable. Because the student-level administrative data provide a fairly small number of student background characteristics, measured home language serves as a proxy for a wide variety of relevant student characteristics that are not in the regression. Examples of such characteristics include family income, parental education, exposure to discrimination, English proficiency, and cultural practices related to education, all of which vary across home-language groups and all of which are likely to affect educational outcomes. The coefficient on each home language variable will thus be a composite of "true" language effects and these other effects. This is also true for our measurements of peer effects – the estimated peer effect associated with (for example) the proportion of Punjabi home-language peers will also be a composite. Note, however, for the purposes of evaluating enclaves we are more interested in this composite effect than the isolated effect of language. For example, if Punjabi home-language families tend to have low income, a family's choice to live in a Punjabi enclave is also a choice to live in a low-income enclave. Furthermore, public policies that impact the distribution of students by home language enclaves will tend to have related effects on the distribution of students by income and other characteristics.

4.3 Measuring enclave effects

The fairly rich set of interactions in our models, while necessary to address issues related to enclaves, come at the cost of increased complexity. In particular, those specifications with interaction terms feature up to 16 distinct peer effect coefficients.

To aid in interpreting these results, we also estimate "enclave effects" for each of the major language groups in our study. The enclave effect for a given language group is defined in terms of a counter-factual: by how much is a typical student's exam score different from what it would be if his/her peer group were representative of the student's district (or the province as a whole, or any other aggregation)?

To be more specific, the enclave effect for an individual student i is defined as:

$$ENC_i = \lambda D(X_{i,7})(\bar{X}_{i,7} - E(\bar{X}_{i,7})) \qquad (3)$$

where the expectation E is taken over some specified population of actual students (i.e., not over some hypothetical larger population from which the observed students are some random sample). The enclave effect for some group G is defined as:

$$
\begin{aligned}
ENC^{G} &\equiv E\left(ENC_{i} \middle| i \in G\right) \\
&= \lambda E\left(\left(X_{i,7}\right)\left(\bar{X}_{i,7} - E\left(\bar{X}_{i,7}\right)\right) \middle| i \in G\right)
\end{aligned}
\tag{4}
$$

where again the expectation is taken over some specified population of actual students. Since the enclave effect is a linear function of the parameter vector λ, inference on it can be based directly on the estimated parameter vector $\hat{\lambda}$ and its covariance matrix.

5 Results

5.1 Regression results

Table 6 reports our main regression results. As discussed earlier, the population under analysis is non-Aboriginal students in both public and private schools who took the grade 7 exams between 2002 and 2004, and who also took the grade 4 exams in 1999 or later. The dependent variable in all regressions is the test score gain between grades 4 and 7. Test score levels are standardized to have unit variance, so all coefficients can be interpreted in units of one standard deviation in the level[8] of the test score. Peer group composition is being reported in decimal rather than percentage units, so each coefficient can be interpreted as the exam score increase (in standard deviations) associated with the percentage of peers in a given category increasing from 0% to 100%. School and year fixed effects are included in all regressions, and estimated standard errors are robust to heteroskedasticity and clustering at the school-year level. Results are reported for both reading and numeracy exams. For each exam, four specifications are reported.

Our base specification (1) excludes any information about ESL status, and ignores any interactions between individual and peer group characteristics. In both subjects, we see positive but small and statistically insignificant peer effects from Chinese home-language peers relative to the excluded category of English home-language peers. Punjabi home-language peers are associated with a negative peer effect in both subjects. This effect is twice as large in the numeracy exam as in the reading exam, and is statistically significant at the 10% level in reading and at the 1% level in numeracy. To get a more concrete idea of the magnitude of these effects, note that they imply that a 25 percentage point increase in the proportion of peers who are Punjabi home-language is associated with a reduction in the student's reading test score by 5.5% (0.22*0.25=0.055) of a standard deviation and a reduction in his or her numeracy test score by 11.3% (0.45*0.25=0.1125) of a standard deviation.

Specification (2) allows the effect of peer home language to vary by a student's own home language. These interaction terms allow direct investigation of whether students from a non-English household fare better or worse when a larger number of their schoolmates speak the same home language as they do. We have implemented this

[8] To interpret coefficients in units of one standard deviation in the dependent variable (exam score gain), simply multiply by the standard deviation of the gain reported in Table 5 (i.e., 0.81 for numeracy and 0.79 for reading).

specification by leaving in the original peer variables along with the peer variables interacted with each of the non-English home languages. As a result, the coefficient on the original peer language variables tells us the corresponding association with the outcome variable for English-language students only. As Table 6 shows, estimated peer effects for English-language students in specification (2) are very similar in magnitude to those predicted for students of all languages in specification (1). The only substantial difference is that the coefficient on "% Punjabi-language peers" changes from -0.22 and marginally statistically significant to -0.17 and marginally insignificant.

The coefficients on the interaction terms tell us the differential response of students with varying home languages to the home languages of their peers. The overall result here is that there is little evidence for major differences in response to peers. An F-test of the null hypothesis that there is no differential response (i.e., the coefficients on the interaction terms are all zero) returns a p-value of 0.84 for the numeracy exam and 0.14 for the reading exam.

Although nearly all of the individual interaction coefficients are statistically insignificant, there are some patterns of interest in the point estimates. Concentration by home language has if anything a negative association with the test score gain, with the coefficients on "Chinese * peer % Chinese", "Punjabi * peer % Punjabi", and "Other * peer % other" all being negative (in the range of -0.03 to -0.10). The negative association of "% Punjabi-language peers" with test score gain is if anything stronger for students with non-English home languages. The only large and statistically significant interaction term turns out to be something of a puzzle: the interaction between "Chinese home-language" and "peer % other home-language" in the reading exam. It is somewhat difficult to make sense of results for the "other" home-language group, given its heterogeneity.

Specifications (3) and (4) add information on the ESL status of students and their peers. Specification (3) leaves out own-language/peer-language interactions, while specification (4) includes those interactions. In both subjects and both specifications, a student's current ESL status is positively associated with test score gains. This result may seem counterintuitive, but it is important to remember what current ESL status measures in this context. If a student is in ESL in grade 7, the provincial 5-year limit on ESL funding means that his or her family entered B.C. (and in many cases, Canada) when he or she was either in grade 3 or grade 4. Given this, our results are consistent with the test scores of these students being temporarily low in grade 4 while the students adapt to life in B.C. Peer ESL status has a positive and weakly significant association with numeracy test scores, and almost no association with reading test scores. Inclusion of own and peer ESL status in the model does not substantially change any other coefficient estimates.

The estimated coefficients on individual-level variables are stable across specifications and are consistent with what we see in the descriptive statistics. In addition, these coefficients are estimated fairly precisely because they are less affected by the clustering than are the coefficients on peer variables. Boys lose ground relative to girls on the reading exam, and gain ground on the numeracy exam. Students who speak home languages other than English improve in both subjects relative to English home-language students. These gains are weakest for Punjabi home-language students and strongest for Chinese home-language students. In addition, we know from the summary statistics that the relative gains of Punjabi home-language students take the form of a narrowing in a test score gap that remains large as of grade 7.

Finally, we note that neither the proportion of male peers nor the proportion of Aboriginal peers appears to have a substantial effect on the test score gain. The coefficients on these variables are statistically insignificant and close to zero for both exams and in all four specifications.

5.2 Enclave effects

Table 7 reports estimated enclave effects for the three largest home-language categories. We report these for three comparison groups: the province as a whole, the district with the largest Chinese home-language population, and the district with the largest Punjabi home-language population. The district with the largest Punjabi home-language population is also the largest district overall, and the district with the largest Chinese home-language population is the second largest district overall. The effects are estimated with and without interactions between own language and peer language, i.e., from specifications (1) and (2) in Table 6. A positive enclave effect indicates that the typical student earns a higher test score because they attend school with peers who are not representative of the composition of peers under the counterfactual.

For English-speaking students, enclave effects are almost uniformly small, with a range of -0.6% to 2.0% of a standard deviation. English home-language students are a large majority in the province, and are a majority in most districts, so as a mechanical matter their peer groups are not all that different from the population as a whole. The largest enclave effect for English home-language student appears in the numeracy exam results for the district with the largest Punjabi-language population. Here, there are enough Punjabi home-language students in the district, and the district's schools deviate far enough from perfect integration that the negative peer effect of Punjabi home-language classmates produces a small but statistically significant enclave effect.

For Chinese home-language students, enclave effects are generally positive but small, and are statistically significant in about half of the estimates. They are particularly small in the district with the largest Chinese home-language population.

For Punjabi home-language students, enclave effects are large and negative for the numeracy exam. In the reading exam, enclave effects are also negative if somewhat smaller and not always statistically significant. These students generally attend schools with a sizeable proportion of Punjabi home-language peers relative to the population as a whole, so the negative estimated peer effect of Punjabi home-language peers has a substantial negative effect on predicted test scores.

5.3 Robustness checks

Table 8 includes a selection of results from estimating alternative specifications of the model. Most of these alternative specifications are robustness checks that relax key restrictions in order to see which if any are critical in generating the main results. A few of the alternative specifications impose additional restrictions.

The first alternative specification uses a modified value-added (MVA) model (Todd and Wolpin 2005) rather than a simple value-added (SVA) model. In the MVA model the dependent variable is the grade 7 test score and grade 4 test scores are used as a control variable. Coefficients on peer group composition are interpreted as in the SVA model. Todd and Wolpin (2005) show that the MVA model has the advantage of relaxing the SVA model's strong assumption that past inputs have the same impact on the current test score as on the past test score. This advantage comes at a cost of increased sensitivity to measurement error, which is why our main estimates are based on the SVA model. As the table shows, use of the MVA model does not have much effect on the relevant parameter estimates. The coefficient on "Peer % Punjabi" does move from marginally significant to marginally insignificant.

The next alternative specification uses another variation on the SVA model in which the dependent variable is the binary progress indicator described in Section 3.2. The binary progress indicator measures whether or not the student's grade 7 exam result represents an improvement over his or her grade 4 result, treating nonparticipation as equivalent to the lowest possible exam score. By treating nonparticipation as an outcome, we avoid bias due to differential participation. As the dependent variable here is on a different scale from that used in the baseline regression, coefficient signs can be compared with the baseline results but not coefficient size. As the table shows, the use of this binary progress indicator modifies but does not overturn the qualitative findings for the simple value-added model. As with the SVA model, a higher proportion of Punjabi home-language peers is associated with a substantial reduction in performance on the numeracy exam. The results imply that a 10 percentage point increase in Punjabi home-language peers (with a corresponding 10 percentage decrease in English home-language peers) would be associated with a 3 percentage point decrease in the probability of improving on the numeracy exam. The positive but statistically insignificant effect of "Peer % Chinese" on both exam outcomes seen in the baseline results becomes essentially no effect. The negative and marginally statistically significant effect of "Peer % Punjabi" on reading exam outcomes seen in the baseline results becomes marginally insignificant.

Next, we estimate a "levels" model of the education production function, i.e., one with the grade 7 test score as the dependent variable rather than the test score gain as in the value added model. The levels model is frequently criticized in the literature because it implicitly assumes past inputs are either irrelevant or unrelated to current inputs. However, it is often used when the data are insufficiently rich to estimate value-added models, so it is useful to know whether the results would be different if we only had the grade 7 data. As the table shows, the levels model estimates are similar to those of the value-added model, with one exception: the coefficient on "Peer % Punjabi" for the reading exam goes from a negative and marginally significant effect to approximately no effect.

Next, we estimate the model without school fixed effects. As with the levels regression, these results are not being considered as a robustness check – the specification with fixed effects is less restrictive than the specification without them – but rather as providing information on the importance of a particular element of our research design. In this case the results actually are dramatically different. The choice to include school fixed effects is thus an important one.

The next alternative specification includes fixed effects for the principal as well as the school. Principals change schools frequently in B.C., and there is some evidence that principal quality is an important determinant of school quality (Coelli et al. 2007). We find that this modification has some effect on coefficient estimates, in particular raising the estimated effect of "peer % Chinese" on reading achievement and making it marginally statistically significant.

The next two alternative specifications include information on the grade 5 and 6 peer group. Our base specification only includes composition of the grade 7 peer group, but the exams are in grades 4 and 7. Therefore in the base specification the grade 7 peer group acts as a proxy for the grade 5 and 6 peer groups as well. To check the robustness of our findings to including the grade 5 and 6 peer groups, we replace the grade 7 peer group composition with the average over grades 5 through 7. One complication with doing so is that many students change schools between grade 5 and grade 7. It is not feasible to have a separate school fixed effect in each grade, which is why our baseline results do not include grade 5 or 6 peer group. We address this issue in two ways. First, we estimate the model only on the subset of students who do not change schools between grades 5 and 7. For this subsample, there is no need for separate fixed effects for each grade. Second, we estimate the model on the full sample, but only including a single fixed effect based on the school attended for grade 7, and using grade 7 peer group composition as an instrumental variable for grade 5-7 average peer group composition. In both cases, the estimated negative impact of peer % Punjabi on numeracy scores is even larger than in the baseline estimates, while the estimated impact of peer % Punjabi on reading scores becomes statistically insignificant.

The next alternative specification uses the pooled sample of Aboriginal and non-Aboriginal students, with the student's own Aboriginal status added to the model as a control variable. These results are almost identical to the baseline results, suggesting that the choice to leave out the Aboriginal students was not a critical one.

The next two alternative specifications estimate the model separately for boys and girls, including gender-specific school and year fixed effects. Here, the point estimates suggest that girls are more influenced by peers than boys, though the differences are not large or statistically significant.

6 Conclusion

This study finds mixed evidence on the hypothesis that peer group composition affects academic achievement among British Columbia students. The language spoken at home by one's peers has a substantial association with numeracy achievement, but the association varies substantially by the peers' specific home language. Specifically, a higher proportion of Punjabi home-language schoolmates has a strong negative association with test scores, while the proportion of Chinese or Other home-language schoolmates has a weak positive association with test scores. This pattern of findings, combined with the variation in achievement levels by language group, suggests that language is acting as a proxy for other aspects of learning behavior.

Our results mirror the findings of other recent studies (e.g., Borjas 1995, 1998; Gang and Zimmerman 2000; Edin et al. 2003; Cutler et al. 2007) that the effect of living in an immigrant or ethnic enclave depends critically on ethnic group characteristics such as the average level of human capital. We find that the effect on achievement of attending school with more same-language peers depends on the achievement level of one's own language group. Our results suggest that linguistic or ethno-cultural similarity to peers does not in itself play a significant role in immigrant success, but rather that human capital and cultural norms of peers is what matters. However, we must be cautious about making claims about the effects on achievement of attending enclave schools. Our empirical methodology exploits random variations in composition that are generally small, so this approach is unable to capture any potentially important non-linearities. Sociological research on enclaves (e.g. Portes 1987) emphasizes "critical mass" mechanisms that are likely to produce nonlinearities. In addition, our approach isolates peer effects operating at the same-grade schoolmate level and below, and will (by design) provide no information about peer effects at a higher level of aggregation like the school or neighborhood. Peer effects may be entirely different in these contexts.

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Tables

Table 1: Per student funding to B.C. public school districts in Canadian dollars, by funding category.

Category	before March 2002	after March 2002
Base amount	3,042	5,308
Aboriginal supplement	755 – 1,030*	950
ESL supplement (maximum 5 years per student)	1,230 (Year 1) 1,060 (Years 2-5)	1,100
Special needs supplements:		
Dependent	31,910	30,000
Low incidence/high cost	12,460	15,000
Severe behavior	6,014	6,000
High incidence/low cost	3,132	0
Gifted	341	0

Source: B.C. Ministry of Education (2002), page 4.
*Amount per student increases with total number of Aboriginal students in the district during this period.

Table 2: Characteristics of grade 7 non-Aboriginal students 2002-2004.

Variable	**English**	**Chinese**	**Punjabi**	**Other**	**Total**
# of observations	110,310	9,865	5,076	14,359	139,610
as % of total	79.0	7.1	3.6	10.3	100.0
% male	51.1	51.5	52.9	52.3	51.3
% currently in special education	10.5	6.2	5.4	6.0	9.5
% gifted	2.6	2.7	0.5	1.2	2.4
% disabled	7.9	3.5	4.9	4.8	7.1
% in ESL now (grade 7)	0.5	24.8	14.2	26.9	5.4
% in ESL in grade 4	1.9	73.6	69.8	55.8	13.2
% in ESL ever	4.5	93.4	92.4	76.6	21.5
Mean % Aboriginal peers	8.3	3.2	5.7	5.0	7.5
	(10.0)	(5.0)	(6.9)	(6.9)	(9.5)
Mean % disabled peers	7.9	7.5	7.6	7.7	7.8
	(6.6)	(6.0)	(5.6)	(6.5)	(6.5)
Mean % English-language peers	87.8	43.9	49.7	54.7	79.9
	(17.6)	(23.8)	(28.5)	(27.9)	(25.1)
Mean % Chinese-language peers	3.6	33.8	6.1	13.2	6.8
	(9.1)	(21.5)	(11.9)	(16.7)	(14.0)
Mean % Punjabi-language peers	2.0	3.2	29.1	5.3	3.4
	(6.0)	(6.4)	(26.3)	(11.2)	(9.8)
Mean % other-language peers	6.5	19.2	15.1	26.8	9.8
	(9.4)	(11.6)	(11.8)	(22.9)	(13.6)
Mean % peers currently in (traditional) ESL	3.2	15.4	13.6	10.8	5.2
	(6.0)	(12.2)	(21.8)	(10.7)	(9.2)

Standard deviations are in parentheses

Table 3: Participation in FSA exams, grade 7 non-Aboriginal students 2002-2004.

Variable	English	Chinese	Punjabi	Other	Total
% taking grade 7 numeracy exam	91.0	91.3	92.6	87.1	90.7
% taking grade 7 reading exam	92.4	89.5	93.4	86.1	91.6
% excused from grade 7 numeracy exam	3.6	5.8	4.1	7.3	4.2
% excused from grade 7 reading exam	3.2	7.7	4.0	9.0	4.2
% without numeracy gain data*	11.8	13.1	12.8	17.8	12.4
% without reading gain data *	10.2	13.2	11.5	16.3	10.9
% without numeracy progress indicator*	3.0	1.8	2.7	3.5	3.0
% without reading progress indicator*	2.8	2.0	2.3	3.4	2.8

* As a proportion of grade 7 students who also attended a B.C. school during grade 4.

Table 4: Trends in numeracy exam participation, grade 4 and 7 non-Aboriginal students 1999-2004.

Year	Grade 4 Numeracy		Grade 7 Numeracy	
	% Taking	% Excused	% Taking	% Excused
1999	91.7	4.6	92.4	4.3
2000	92.2	4.2	91.7	4.1
2001	90.9	5.9	90.8	5.7
2002	90.8	4.5	91.1	4.4
2003	90.0	4.5	90.0	4.4
2004	89.9	4.3	89.9	4.0

Table 5: Achievement levels and growth by home language, grade 7 non-Aboriginal students 2002-2004.

Variable	English	Chinese	Punjabi	Other	Total
Grade 7 numeracy score	-0.00	0.71	-0.19	0.07	0.05
	(0.96)	(1.02)	(0.99)	(1.04)	(0.99)
Grade 7 reading score	0.08	0.23	-0.36	-0.15	0.06
	(0.97)	(0.98)	(0.96)	(1.00)	(0.98)
Gain in numeracy score	-0.08	0.29	0.16	0.14	-0.03
	(0.79)	(0.83)	(0.91)	(0.82)	(0.81)
Gain in reading score	-0.02	0.20	0.09	0.16	0.01
	(0.79)	(0.77)	(0.78)	(0.79)	(0.79)
% showing progress in numeracy	45.1	66.4	57.9	58.2	48.0
% showing progress in reading	49.5	62.8	55.5	60.4	51.5

Standard deviations in parentheses

Table 6: Regression results, simple value-added model (dependent variable is change in test score).

Variable	Numeracy exam				Reading exam			
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
Male	0.02***	0.02***	0.02***	0.02***	-0.09***	-0.09***	-0.09***	-0.09***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Chinese spoken at home	0.24***	0.22***	0.23***	0.21***	0.15***	0.13***	0.14***	0.11***
	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)
Punjabi spoken at home	0.07***	0.07**	0.07***	0.06**	0.05***	0.05*	0.04***	0.04
	(0.02)	(0.03)	(0.02)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)
Other language at home	0.15***	0.15***	0.13***	0.13***	0.12***	0.15***	0.10***	0.13***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
% male peers	0.00	0.00	0.00	0.00	-0.03	-0.03	-0.03	-0.03
	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
% Aboriginal peers	0.04	0.04	0.03	0.03	-0.06	-0.06	-0.06	-0.06
	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)
% Chinese-language peers	0.17	0.13	0.14	0.11	0.13	0.16	0.13	0.16
	(0.13)	(0.13)	(0.13)	(0.13)	(0.11)	(0.11)	(0.11)	(0.11)
% Punjabi-language peers	-0.45***	-0.46***	-0.46***	-0.46***	-0.22*	-0.17	-0.21	-0.17
	(0.15)	(0.16)	(0.15)	(0.16)	(0.13)	(0.13)	(0.13)	(0.13)
% other-language peers	0.03	0.05	-0.01	0.01	0.00	0.00	0.00	-0.00
	(0.10)	(0.10)	(0.11)	(0.11)	(0.08)	(0.08)	(0.08)	(0.09)
Chinese*peer % Chinese		0.07		0.08		-0.07		-0.07
		(0.07)		(0.07)		(0.07)		(0.06)
Chinese*peer % Punjabi		-0.05		-0.04		-0.09		-0.09
		(0.16)		(0.17)		(0.16)		(0.16)
Chinese*peer % Other		0.03		0.02		0.25**		0.24**
		(0.10)		(0.10)		(0.10)		(0.10)
Punjabi*peer % Chinese		-0.07		-0.07		-0.09		-0.09
		(0.14)		(0.14)		(0.13)		(0.13)
Punjabi*peer % Punjabi		-0.03		-0.02		-0.10		-0.09
		(0.12)		(0.12)		(0.11)		(0.11)
Punjabi*peer %Other		0.09		0.12		0.11		0.15
		(0.14)		(0.14)		(0.15)		(0.15)
Other*peer %Chinese		0.08		0.07		0.01		-0.00
		(0.07)		(0.07)		(0.07)		(0.07)
Other*peer %Punjabi		0.07		0.06		-0.13		-0.14
		(0.09)		(0.09)		(0.10)		(0.10)
Other*peer %Other		-0.08		-0.07		-0.08		-0.08
		(0.07)		(0.07)		(0.07)		(0.07)
Currently ESL			0.17***	0.17***			0.20***	0.19***
			(0.03)	(0.03)			(0.03)	(0.03)
% (traditional) ESL peers			0.24*	0.24*			0.01	-0.00
			(0.14)	(0.14)			(0.12)	(0.12)
ESL*peer % ESL			0.06	0.04			0.15	0.17
			(0.19)	(0.19)			(0.19)	(0.19)
Observations	112,569	112,569	112569	112569	114,486	114,486	114486	114486
R^2	0.13	0.13	0.13	0.13	0.06	0.06	0.06	0.06

Cluster-robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
School and year fixed effects in all regressions.

Table 7: Enclave effects by language spoken at home, based on coefficient estimates in columns (1) and (2) of Table 6.

Comparison Group	**Home Language**	**Numeracy exam (1)**	**Numeracy exam (2)**	**Reading exam (1)**	**Reading exam (2)**
Province	English	0.0	0.1	-0.2	-0.3
		(0.6)	(0.6)	(0.5)	(0.5)
	Chinese	4.7	6.3	3.8	4.8
		(3.8)	(4.0)	(3.1)	(3.6)
	Punjabi	-11.7***	-11.8***	-5.7*	-6.3
		(3.9)	(4.3)	(3.4)	(4.0)
District with largest Chinese-language population	English	0.1	0.1	-0.3***	-0.6
		(1.1)	(1.1)	(0.1)	(0.9)
	Chinese	2.0*	2.4**	1.4	0.9
		(1.2)	(1.2)	(1.0)	(1.1)
	Punjabi	-10.8***	-10.0***	-5.6*	-5.5
		(3.3)	(3.6)	(2.9)	(3.4)
District with largest Punjabi-language population	English	2.0***	2.0***	1.0	0.8
		(0.7)	(0.8)	(0.7)	(0.7)
	Chinese	3.2***	3.8***	1.8**	2.4*
		(1.0)	(1.4)	(0.9)	(1.2)
	Punjabi	-8.8***	-9.0***	-4.4*	-5.0*
		(2.9)	(3.2)	(2.5)	(2.9)

Cluster-robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 8: Selected regression coefficients under alternative model specifications.

Description	Numeracy exam		Reading exam	
	Peer % Chinese	Peer % Punjabi	Peer % Chinese	Peer % Punjabi
Base specification	0.17	-0.45***	0.13	-0.22*
(Table 6, column 1)	(0.13)	(0.15)	(0.11)	(0.13)
Modified value-added	0.14	-0.42***	0.11	-0.17
(MVA) model	(0.11)	(0.13)	(0.10)	(0.11)
Binary value-added	0.01	-0.31***	0.00	-0.10
(BVA) model	(0.07)	(0.08)	(0.07)	(0.09)
Levels model	0.11	-0.35**	0.22*	-0.01
	(0.12)	(0.14)	(0.11)	(0.13)
No school fixed effects	0.38***	0.50***	0.16***	0.15
	(0.05)	(0.18)	(0.04)	(0.09)
Principal and school	0.06	-0.34**	0.20*	-0.18
fixed effects	(0.15)	(0.14)	(0.12)	(0.14)
Grade 5-7 peers	0.18	-0.70***	0.14	-0.07
(non-movers only)	(0.17)	(0.24)	(0.15)	(0.20)
Grade 5-7 peers	0.19	-0.72***	0.16	-0.35
(grade 7 peers as IV)	(0.18)	(0.24)	(0.15)	(0.21)
Aboriginal students included	0.18	-0.41***	0.13	-0.22*
	(0.13)	(0.15)	(0.11)	(0.13)
Boys only	0.15	-0.41**	0.13	-0.14
	(0.15)	(0.17)	(0.13)	(0.15)
Girls only	0.18	-0.48***	0.16	-0.28*
	(0.16)	(0.16)	(0.14)	(0.16)

Cluster-robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1