

Policy Implications of Ethnic Peer Group Effects in a Danish Lower Secondary Context

by

Simon Calmar Andersen
Dept. of Political Science
Aarhus University
Denmark

Corresponding author's e-mail: simon@ps.au.dk

and

Mette K. Thomsen
Dept. of Political Science
Aarhus University
Denmark

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Abstract

Immigrant students perform worse on average in lower secondary school than native students do. Part of the effect may not stem from the immigrant students themselves, but from the student composition at the school. From a policy perspective the latter aspect is quite interesting, since it is more feasible to change student composition in schools than the socioeconomic status of the students. This paper describes theoretically the circumstances under which total student attainment can be increased by reallocating certain groups of students. Empirical analyses of Danish register data of more than 40,000 students suggest that the gain in total student attainment by reallocating immigrant students is minor. However, the achievement of immigrant students can – *ceteris paribus* – be increased, without decreasing native students' attainment, by limiting the share of immigrant students at any one school to 50 percent.

Introduction

Many Western countries have experienced an increase in the total number of immigrants especially over the last two decades. In Denmark, for instance, 9.1 percent of the population in 2008 was first or second generation immigrants compared to just 4.1 percent in 1990 (INM, 2008: 6). Immigrants tend to concentrate in areas around the big cities (for Danish examples, see Damm, 2002; Andersen & Børresen, 2006) leading to high ethnic and socioeconomic segregation – not least at school level.

Immigrant students perform worse on average in lower secondary school than native Danish students do (see e.g. Colding, Hummelgaard & Husted, 2005: 691). This may be due to characteristics related to immigrant students, such as language skills and weak socioeconomic status, but part of the effect may stem not from the immigrant students themselves, but from the student composition at the school. From a policy perspective the latter aspect is quite interesting, since it is more feasible to change student composition in schools than the socioeconomic status of the students. However, only a few empirical studies of the effect of racial or immigrant composition on educational outcome, so-called immigrant or racial peer group effects, have been conducted (Coleman et al., 1966; Hoxby, 2000; Rivkin, 2000; Hanushek, Kain, & Rivkin, 2002; Szulkin & Jonsson, 2007; Jensen & Würtz, 2008) – and only Hoxby (2000) explicitly addresses the question of whether reallocating certain groups of students will increase total student achievement, and hence lead to efficiency gains. From a policy perspective, the relevant question is not (only) whether student composition on average affects students' educational outcome, but

whether a more even allocation of immigrant students across schools will increase the total student achievement.

This paper aims at answering the latter question first by showing theoretically how the answer depends on whether the functional form between ethnic concentration and achievement is concave or convex. Furthermore, it shows how asymmetric peer group effects, i.e. different effects of ethnic concentration on immigrants' and native students' educational outcome, may explain such non-linear relationships. None of the existing studies mentioned above analyse this intimate relationship between non-linear and asymmetric peer group effects. Secondly, the paper uses a large and detailed register dataset of more than 40,000 Danish students, which facilitates a precise test of the character of the peer group effects. Studies using smaller datasets have not been able to differentiate between the effects of proportions of immigrant students greater than fifty percent. With detailed register data we are also able to reduce the potential omitted variable bias in analyses of peer group effect, due to unobserved control variables affecting both ethnic concentration and students' educational outcome.

Contrary to some of the existing studies, this paper reaches the conclusion that reallocating immigrant students could be an effective means to increase the total amount of learning, since it improves immigrant students' educational outcome at essentially no expense to the native Danish students.

The rest of the paper is structured as follows. Firstly, central theoretical aspects relevant to this study as well as results from the research literature on peer group effect are presented and discussed. The next section describes the Danish educational system, the dataset and the methodology used in the analysis. Then, research results are presented and, finally, the policy implications of the empirical results are discussed.

Theory and Evidence on Ethnic Peer Group Effects

Theory

The mix of students in a school class can affect the individual student's educational outcome in a variety of ways. Classmates may be positive or negative role models. The behaviour and attitudes of classmates may affect the learning environment in the class. Children observe and learn from each other's behaviour regarding, for instance doing homework and taking the school seriously. Students' educational outcome is also affected more directly by the behaviour of their classmates, e.g. disruptive behaviour or asking productive questions. The above examples of peer group effects are just a couple among of the many presented in the theoretical literature (for further examples, see e.g. Hoxby, 2000; Schneeweis & Winter-Ebmer, 2007; Rangvid, 2007a).

In order to answer whether the total student achievement can be increased by reallocating immigrant students, two theoretical relationships are of particular interest: nonlinear peer group effects and asymmetric peer group effects. If either of the relationships exists, efficiency gains, in the sense of increasing the total student achievement, can be achieved by reallocating certain group of students. To understand this, we start looking at the opposite, namely linear relationships.

In the case of linear peer group effects the marginal effects on a student's educational outcome of increasing the ethnic concentration will be the same in classes with few or many immigrant students (Henderson, Mieszkowski & Sauvageau, 1978: 102ff). Therefore, total student achievement will not be affected by reallocation. This can be seen theoretically as follows:

Let A be the total student achievement in a society, and a_s be the student achievement in school s . I is the number of immigrant students in society, N the number of native students, and i_s and n_s the number of immigrant students and native students in school s .

We will show that if the relationship between share of immigrant students, $\frac{i_s}{i_s + n_s}$, and achievement is linear on a school basis, total student achievement as the sum of student achievement in each school does not depend on the number or share of immigrants in each school.

Achievement in school s , is

$$a_s = \alpha + \beta \frac{i_s}{i_s + n_s} \quad (1.)$$

where α is a constant, and β is the ethnic peer group effect of on achievement. Total student achievement, A , is calculated as the sum achievement in each school weighted by the number of students in that school. In that case we have:

$$A = \frac{\sum_s a_s (i_s + n_s)}{I + N} = \frac{\sum_s (\alpha (i_s + n_s) + \beta \frac{i_s}{i_s + n_s} (i_s + n_s))}{I + N} = \frac{\alpha \sum_s (i_s + n_s) + \beta \sum_s i_s}{I + N} = \alpha + \beta \frac{I}{I + N} \quad (2.)$$

Hence, in situations with linear peer group effects there is no effect on the total amount of learning of reallocating students between different schools, i.e. reallocating immigrant students does not concern efficiency. In order to be able to give one student a better peer, one must take that peer away from another student and all effects therefore cancel each other out (Feinstein & Symons, 1999: 304; Hoxby, 2000: 2). If only linear peer group effects

can be identified, policy makers are, however, still able to affect the educational outcome of a certain group of students by reallocating students. From an equity perspective, policy makers may decide to reallocate immigrant students due to the positive effects that immigrant students especially gain from being in ethnic mixed classes (Argys et al, 1996: 640f; Rangvid, 2007a: 377).

With nonlinear peer group effects the total amount of learning can be increased by reallocating students, because the marginal effect on a student's educational outcome by increasing the ethnic concentration will depend on the existing number of immigrant students at his or her school. Depending on the nature of the nonlinear peer group effect, different forms of allocation of immigrant students will increase the total amount of learning.

In the case of increasing the marginal (negative) effect of ethnic concentration, the relationship between ethnic concentration and educational outcome is concave, and the situation can be described as follows.

$$p = \frac{i}{i + n} \quad \text{Let } f(p) \text{ be the function relating the share of immigrants, } p, \text{ to student achievement, where} \quad (3.)$$

$f(p)$ is strictly concave if

$$f(tp_1 + (1-t)p_2) > tf(p_1) + (1-t)f(p_2) \quad (4.)$$

for any t in $(0,1)$ and $p_1 \neq p_2$.

The right side of this inequality describes the weighted average of the achievement of two schools, with a different share of immigrants, p_1 and p_2 . This weighted average will lie somewhere on a straight line between $f(p_1)$ and $f(p_2)$, depending on the weight, t (see Figure 1). The definition of concave functions means that the weighted average of the achievement of two schools will be less than the achievement, if the immigrants are reallocated to somewhere between p_1 and p_2 , since $f(p)$ is greater than the straight line. Thus, with increasing marginal (negative) effects, establishing a more even allocation of immigrant students across schools will lead to efficiency gains. Theoretically, immigrants

can be reallocated until all schools have the same share of immigrants, $\bar{p} = \frac{I}{I + N}$. Hence, if $f(p)$ is concave, total student achievement will be maximised at $f(\bar{p})$.

[Figure 1 about here]

A special case of a concave function is a tipping or threshold point (see Figure 2), i.e. when the ethnic concentration reaches a critical point the students' educational outcome declines dramatically (see Kahlenberg, 2005: 39f).

[Figure 2 about here]

This function is not concave in the area below the tipping point, p' . Hence if $\bar{p} < p'$ there is no gain in total student achievement from reallocating immigrant students from schools with a share of immigrants less than p' . Thus total student achievement is maximised by restricting the ethnic concentration below the tipping point.

In the case of decreasing marginal (negative) effect of ethnic concentration, the relationship between ethnic concentration and educational outcome can instead be described by a convex function. In the case of strictly convex functions, we have

$$f(tp_1 + (1-t)p_2) < tf(p_1) + (1-t)f(p_2) \quad (5.)$$

and the situation is opposite. In this case total achievement is increased as the difference between p_1 and p_2 increases. Hence, total student achievement is maximised if p is either 0 or 1. Thus, with decreasing marginal (negative) effects, establishing more ethnic stratified classes will lead to efficiency gains. Total student achievement is maximised when all immigrant students attend schools with 100 percent immigrants and native students attend schools with 0 percent immigrants.

[Figure 3 about here]

Another theoretical relationship, often studied in the peer literature, is asymmetric peer group effects. In case of asymmetric peer group effects, certain groups of students are more affected by the peer group composition than others, e.g. the educational outcome of immigrant students is more affected by the ethnic concentration than the educational outcome of native students. It is often noticed that in the case of asymmetric peer group effects efficiency gains can be achieved by reallocating certain groups of students (see e.g.

Schneeweis & Winter-Ebmer, 2007; Rangvid, 2007a). It is not seen in the existing literature, however, that this is due to a close relationship between asymmetric and nonlinear peer group effects. This can be seen from the following mathematical argument.

The achievement (A) of natives (N), immigrants (I), and all students totally (T) as a function of peer group effects (β), share of immigrants (p), and a constant (α), measuring other inputs can be described like this, if linear, but not necessarily symmetric peer group effects in each of the two groups, native students and immigrant students, are assumed:

$$A_N = \alpha_N + \beta_N p \quad (6.)$$

$$A_I = \alpha_I + \beta_I p \quad (7.)$$

$$A_T = (1-p)A_N + pA_I = (1-p)(\alpha_N + \beta_N p) + p(\alpha_I + \beta_I p) \quad (8.)$$

$$A_T = \alpha_N + \beta_N p - \alpha_N p - \beta_N p^2 + \alpha_I p + \beta_I p^2 \quad (9.)$$

$$A_T = \alpha_N + (\beta_N + \alpha_I - \alpha_N)p + (\beta_I - \beta_N)p^2 \quad (10.)$$

The mathematical argument shows that if the effect of ethnic concentration is linear for both natives and immigrants, as in equations (6.) and (7.), the peer group effect for all students is quadratic, as in equation (10.). Hence, if (linear) asymmetric peer group effects exist ($\beta_I \neq \beta_N$), the peer group effect for all students will be nonlinear.¹

Furthermore it is seen that if $\beta_I > \beta_N$, i.e. the peer group effect for immigrant students is less negative (smaller effect) than for native students, the quadratic coefficient ($\beta_I - \beta_N$) is positive, and the curve for all students is convex – in this case decreasing marginal negative effects. This is illustrated in Figure 4.

[Figure 4 about here]

As described above, in the case of decreasing marginal (negative) effects, i.e. a convex function, establishing ethnic stratified classes will increase total student achievement, since the negative effects decrease as stratification increases.

On the other hand, if $\beta_I < \beta_N$, i.e. the peer group effect for immigrant students is more negative (stronger effect) than for native students, the quadratic coefficient ($\beta_I - \beta_N$) is negative and the curve for all students is concave – in this case increasing marginal negative effects. This is illustrated in Figure 5.

[Figure 5 about here]

In this case, mixing native and immigrant students will increase the total amount of learning, because the negative effect increases as stratification increases. Total student achievement is maximised at \bar{p} , as described above.

Finally, if $\beta_I = \beta_N$, i.e. the peer group effects are symmetric for immigrants and natives, the total curve is, of course, linear, and there will be no net gain from reallocating students.

In summary, to find out whether reallocating students leads to efficiency gains, one only needs to find out whether the curve for all students is linear or nonlinear – and if it is nonlinear whether the marginal (negative) effect increases or decreases, i.e. whether the functional form is concave or convex.² However, to find out why a nonlinear relationship exists, one can study whether the ethnic concentration affects natives and immigrants asymmetrically.

Existing evidence

Peer group effects have been studied intensely in an American context, where researchers have focused for decades on the effect of having afro-American peers or/and peers with a weak socioeconomic background (see e.g. Coleman et al, 1966; Henderson, Mieszkowski & Sauvageau, 1978; Hoxby, 2000; Hanushek, Rikvin & Kain, 2002). Many studies about peer group effects focus mainly on identifying a causal peer effect, i.e. do student compositions on average affect the individual child's educational outcome? A couple of American studies, however, analyse whether the ethnic peer group effects are nonlinear or/and asymmetric. Hoxby (2000) in her study, for example, shows that peer group effects primarily work within racial groups, i.e. afro-American students have the strongest affect on afro-American students (Hoxby, 2000: 21). A study by Hanushek et al. (2002: 22ff) also confirms an intra-race peer group effect in an American context. They find that the concentration of afro-American students only affects the educational outcome of afro-American students (Hanushek et al, 2002).

In a European context only a few empirical studies of ethnic peer group effects have been conducted (see Jensen & Smith, 2007; Jensen & Würtz, 2008; Szulkin & Jonsson, 2007). The study by Jensen & Smith (2007) based on Danish PISA data shows that native Danish students' test scores are reduced significantly when the ethnic concentration is 50 percent or more. For immigrant students the test score is reduced significantly by an ethnic concentration of 10 percent (Jensen & Smith, 2007: 117f). Since immigrant students' test scores only reduce marginally when reaching an ethnic concentration above 10 percent the study concludes that reallocating immigrant students will not contribute to improving immigrant students' educational attainment and hence minimising the educational gap between native Danish students and immigrant students (Skolerådet, 2008: 139). The study by Jensen & Würtz (2008), also based on Danish PISA data, on the contrary concludes that policy makers should limit the ethnic concentration to 50 percent, since this is where the

reduction in test scores for Danish students is significant. For immigrant students the negative effects appears already at an ethnic concentration of 5 percent. These effects are, however, not significant due to a small sample size (Jensen & Würtz, 2008: 89ff). The study does not discuss whether reallocating immigrant students will minimise the educational gap between native Danish students and immigrant students.

A Swedish study by Szulkin & Jonsson (2007: 27) recommends that policy makers limit the ethnic concentration to 40 percent immigrants. Similar to our study, they are, due to a relative large sample size, able to make a relatively precise test of the character of peer group effects. As the following sections will show, the present study once again raises the question of the need to reallocate immigrant students in a Danish context.

The Danish School System, Data Set and Methodology

Low educational attainment, especially among many immigrant students, and increasing ethnic and socioeconomic segregation at school level has led to great political concern in Denmark. In order to improve the educational attainment among immigrant students, policy makers have implemented a number of new educational policy instruments in a Danish context over the last decade (see Colding, Hummelgaard & Husted, 2006: 693ff). Among other things policy makers have developed magnet schools and made language stimulation of three-year-old preschool immigrant children with inadequate Danish language proficiency mandatory. Furthermore, municipalities have been given the authority to compel school-age immigrant children with inadequate Danish language skills to attend a public school other than the local one. Despite a number of initiatives in the last decade to improve the educational attainment of immigrant students in a Danish context, the knowledge of e.g. the policy implications of reallocating immigrant students is rather sparse.

Nine years of schooling is compulsory in Denmark. The ninth grade is completed with a number of compulsory examinations. Some students choose to take an optional tenth year in order to be extra prepared for entering upper secondary school, where they can choose between a vocational or academic track (for further information about the Danish educational system, see Colding, Hummelgaard & Husted, 2006; Andersen & Serritslew, 2006; Andersen, 2008). In Denmark around 13 percent of the students attended a private school in 2005.

In this study we examine the effect of ethnic concentration on students' educational outcome at ninth grade examination level in Danish lower secondary public schools. Only schools with at least 10 students at grade level are included in the analysis. With e.g. only eight students attending a ninth grade one immigrant student will result in a

disproportionately high ethnic concentration. Furthermore, the risk of fluctuations in both the average examinations grade and ethnic concentration between two school years are more likely at small schools (Rangvid, 2008: 9). By excluding schools with less than 10 students the probability of a statistical correlation between ethnic concentration and educational outcome, partly caused by random fluctuations in student composition a given year, is reduced.

When estimating the effect of ethnic concentration, we take into consideration the fact that a number of additional factors, besides student composition, have an influence on a student's educational outcome. The educational production function, used in many studies of peer group effects, indicates that a student's educational attainment is given by the following function: $A_i = f(F_i, I_i, S_i, P_i)$ (see Hanushek, 1972 & 1986; Henderson, Mieszkowski & Sauvageau, 1978; Zimmer & Toma, 2000; Robertson & Symons, 2003; Rangvid, 2003; McEwan, 2003; Summers & Wolfe, 1977). A_i refers to educational attainment for student i . F is family input, I is individual characteristics, S is school inputs, and finally P refers to peer inputs. As mentioned earlier, this study is based on Danish register data which contains detailed information at individual level, school level and municipal level. All students who took their ninth grade examinations in a Danish public school in 2005 are included in the dataset, i.e. more than 40,000 students. The fact that the dataset contains very detailed information, makes it very useful for analysing peer group effects, including trying to identify causal peer group effects.

The dependent variable in this analysis is educational outcome. Students, of course, learn more in lower secondary school than can be measured by their final examination grades. Educational attainment is just one of several objects listed in Danish legislation about lower secondary education (see Act no.1049, 28th of August, 2007). Grades are, however, a relatively reliable and valid measure of a central aspect of schooling, namely academic skills.

At the end of ninth grade students attend oral as well as written examinations in a number of compulsory subjects. The written examinations are standardised tests issued by the Ministry of Education and used at all public schools. Furthermore, two central external examiners are appointed. Contrary, oral examinations are not standardised. Teachers are only required to form examination questions in conformity with the requirements in the law with regard to examination requirement and subject area (see departmental order 863, 5th of July, 2007). As a consequence, written examinations are presumably more objective and reliable indicators of students' educational attainment across schools and municipalities than oral examinations are. An average of each students' examination grade in written Danish and mathematics is therefore used as the dependent variable. We use both Danish and mathematic scores to obtain a broad measure of student

achievement. Grades are given on a 10-point scale with special grades for insufficient and excellent performance.³

The independent variable, ethnic concentration, is measured by the share of immigrant students at grade level. As mentioned, the study also controls for a number of variables at individual level, school and municipal level. For a further description of these variables, see table A in the Appendix. In the case of missing information about the father's or mother's education, income or capital this value is set to zero, and a dummy variable, which is set to one, is included in the regression. Six so-called "missing value indicators" are in other words included in our analyses in order to account for the possibility of non-random missing values (see Feinstein & Symons, 1999; Rangvid, 2003 & 2007a; Schneeweis & Winter-Ebmer, 2007; Jensen & Würtz, 2008).

In analyses of peer group effects, there are two methodological problems to be aware of especially. The first and most important is the potential problem of self-selection due to unobserved variables affecting both the ethnic concentration and students' educational outcome. In the case of self-selection the explanatory variable is said to be endogenous. As a result of self-selection the ethnic concentration in many schools are not random. Families often choose to live in areas with people similar to themselves with regard to economic and/or cultural background (see Damm, 2002: 7; Hoxby, 2000: 3). Furthermore, some parents may choose a private school for their child due to the student composition at the local public school (see Jensen & Smith, 2007: 92; Rangvid, 2007b & 2007c). If parents at schools with high shares of immigrants students differ in unobserved ways from parents at other schools, and if these differences also affect the educational outcome of their children – in ways not accounted for by the control variables – the parameter estimate for ethnic concentration will be biased (Evans, Oates & Schwab, 1992: 968; Feinstein & Symons, 1999: 304; Rangvid, 2003: 116f; Robertson & Symons, 2003: 39). As a result, it becomes difficult to determine whether the estimated effect of ethnic concentration is a causal effect or a result of a selection effect.

In the peer literature researchers often mention parental engagement, parental ambitions and cultural, economic and social integration of immigrant families as examples of unobserved variables affecting both peer composition and the children's educational outcome (ibid). We handle the potential problem of self-selection by including detailed information about the individual student's family background in our analysis. A number of other studies of peer group effects also use detailed control variables to reduce some of the omitted variables bias and then estimate peer group effect by the OLS method (see e.g. Rangvid, 2007a; Schneeweis & Winter-Ebmer, 2007). We control for family characteristics and individual characteristics such as: length of parental education⁴, parental income, parental capital, size of residence, rented vs. owned residence, family structure (living with one or both parents), gender, age and ethnicity. It seems very unlikely that

unobserved variables such as parental engagement, parental ambitions and integration of immigrant families should be uncorrelated to the former mentioned family characteristics. Parents with a long education are e.g. often more ambitious with regard to their children's education as well as more likely to choose a private school for their child.⁵

A second methodological problem in this analysis is the hierarchical structure of the dataset: students within schools within municipalities. Often the hierarchical structure of data is ignored by disaggregating data and then using OLS. However, students attending the same school often have more in common than two random students. In that case, the disturbances will be correlated within the schools, and we can therefore not assume a lack of spatial autocorrelation. As a consequence, the standard errors will be downward biased, and hence the findings of statistical significance for the aggregate variables will often be spurious (Moulton, 1990: 334). Typically, two alternatives are used in order to ensure valid inference in the case of clustered data: clustered robust standard errors or multilevel models. Since the differences in estimators of using clustered robust standard error or a multilevel model are small - when the number of clusters (schools) is large (greater than 50 at most) - robust cluster standard errors are recommended for large datasets instead of the computationally demanding multilevel models (see Primo et al. 2007; Green & Vavreck, 2008). We therefore address the problem by using clustered robust standard errors.

Empirical Results

In the following section we describe our empirical results. Firstly, we deal with average peer group effects. Secondly, we test the character of peer group effects, i.e. is the effect of ethnic concentration nonlinear and if so asymmetric?

When estimating the average effect of ethnic concentration, we start by adding control variables to our model according to their causal order to find out how it affects the magnitude and significance of the explanatory variable. When only including ethnic concentration in the analysis, the peer group effect estimate for the explanatory variable is -0.017 and significant at the 0.01 level. Controlling for each student's individual characteristics, family background and school characteristics, however, changes the estimate for ethnic concentration to -0.004 , see table 1. The effect is nevertheless still significant at 0.01 level. Especially, when including family background the magnitude of the effect of ethnic concentration decreases substantial as well as raises the explanatory power of the model. Other Scandinavian studies have also showed that a large proportion of variation in students' educational outcome is due to different family backgrounds among students (Jensen & Würtz, 2008; Szulkin & Jonsson, 2007).⁶

[Table 1 about here]

In summary, the results in table 1 show that the average effect of ethnic concentration on students' educational outcome is negative and significant in the Danish lower secondary school. The average peer group effect is however relatively weak in magnitude, given that moving a student from a class with zero percent immigrant students to a class with 100 percent immigrant students decreases the student's grade by 0.42 points on average on a scale from 0 to 13 with a standard deviation of 1.29 (see table A in the appendix).

We now focus on the main aim of this paper: The character of peer group effect. We firstly examine whether the effect of ethnic concentration is nonlinear. Next, we investigate whether the effect of ethnic concentration is asymmetric. As mentioned earlier asymmetric effects can be an explanation of non-linear effects.

In order to test for constantly decreasing or increasing marginal effects of ethnic concentration a squared term of ethnic concentration is included in the analysis (results not presented). The analysis did not show evidence of any of the two alternative shapings.

To test for a tipping point, the continuous explanatory variable is recoded into nine intervals using dummy variables. With a dataset containing more than 40,000 students we are able to use relative detailed intervals, e.g. 10 percent point intervals, and hence identify a (possible) tipping point fairly precisely. Furthermore it becomes possible to determine whether the negative effects of ethnic concentration flatten out with high ethnic concentration. The use of detailed intervals therefore contributes to a precise test of character of the peer group effect. The results are presented in table 2. The reference category is schools with 0-9.99 percent immigrant students.

[Table 2 about here]

Model 1 in table 2 shows that students attending a school with low ethnic concentration, i.e. 0-9.99 percent immigrant students perform on average better than students enrolled in schools with higher ethnic concentration. For instance, students attending a school with at least 80 percent immigrants achieve on average 1.6 points lower grades than students enrolled in schools with less than 10 percent immigrants. When adding control variables, in model 2-4, students attending a school with less than 10 percent immigrants still perform better on average.⁷ The educational gap between schools with low and high ethnic concentration is, however, less substantial in model 4 than in model 1. From model 4 it is also seen that students attending a school with 0-9.99 on average do not perform substantially or significantly better than students attending a school with 10-49.99 percent immigrants. Hence, up to an immigrant percentage of 50 percent, the student's grades are only modestly affected when changing the percentage of immigrant from e.g. 0-9.99 to 20-29.99 or from 0-9.99 to 30-39.99.

Looking at schools with an immigrant concentration exceeding 50 percent, the reduction in grades becomes more substantial (see model 4). Students attending a school with 50-59.99 percent immigrant students on average receive 0.22 points lower grades than students attending a school with 0-9.99 percent immigrants. Students enrolled in schools with no less than 60 percent immigrants, the average reduction in grades is, however, much higher. Figure 6 presents the results graphically and illustrates the tipping point.

Another implication of the results in table 2 is that the relatively weak average peer group effect estimated in table 1 is in fact due to a weak negative marginal effect of ethnic concentration on students' educational outcome until the ethnic concentration exceeds 50 percent. Only four percent of the schools tested in this analysis have an ethnic concentration with at least 50 percent immigrants. Finally, the results in table 1 imply that the negative effect of ethnic concentration on educational outcome does not flatten out as the ethnic concentration increases (see also figure 3). In fact, on average students' grades are reduced by an additional 0.237 points when the ethnic concentration is changed from 70-79.99 to 80-100 percent. In comparison, students' grades are only reduced by on average 0.137 points when changing the ethnic concentration from 60-69.99 to 70-79.99 percent.

[Figure 6 about here]

As mentioned above, asymmetric peer group effects can explain a non-linear relationship. Table 3 confirms that this is indeed the case. The effect of ethnic concentration on educational outcome is almost twice as great for immigrant students as for native Danish students.

[Table 3 about here]

Finally, we examine if a tipping point is located at 50 percent immigrant students for both immigrant students and native Danish students. These results are presented in table 4. Immigrant students attending a school with at least 20-29.99 or 30-39.99 percent immigrants perform significantly worse than immigrant students attending a school with a low ethnic concentration, i.e. less than 10 percent immigrants. The difference in performance between the reference category and the two former mentioned intervals is however modest. With an ethnic concentration of 70 percent the performance of immigrant students becomes substantially and significantly lower. For instance, immigrant students attending a school with an ethnic concentration of 70-79.99 percent on average achieve 0.31 points lower grades than immigrant students attending a school with less than 10 percent immigrants. While the average grades of immigrant students decline at two points, i.e. around 20 and 70 percent immigrants, which makes it difficult to locate a precise tipping point for immigrant students, it is easier to identify a tipping point for

native Danish students. Thus, table 4 shows that a tipping point can be located at around 50 percent for native Danish students. The last section discusses the implications of these results.

[Table 4 about here]

Concluding Discussion

Knowledge of both the linearity of ethnic concentration and whether certain groups of students are more affected by ethnic concentration than others is important for the assessment of the policy implications of reallocating immigrant students. Firstly, the results of the present study show negative ethnic peer group effects on average. Secondly, analyses related to the linearity of ethnic concentration showed that the educational outcome declines significantly with an ethnic concentration of 50 percent immigrants or more. Thirdly, the analyses dealing with asymmetric peer group effects showed that immigrant students are more affected by ethnic concentration than native Danish students are, and that a tipping point is reached for immigrants with 20 percent immigrant students and with 50 percent for native Danish students.

This pattern of results related to the character of the peer group effects has two important policy implications. Firstly, the total amount of learning would – all else being equal – be improved if the share of immigrant students were limited. More specifically, policy makers may limit the share of immigrants at each school to 50 percent or less. Some of the results suggest rather negative effects already at 20 percent immigrants at each school. However, some municipalities have more than 20 percent immigrants on average. Furthermore, the net gain with regard to the total amount of learning (of reallocating by 20 percent immigrants instead of 50 percent immigrants) is marginal. The reasoning is that few immigrant students will improve their grades with relatively few points if policy makers limit the ethnic concentration to 20 percent instead of 50 percent.

Secondly, our results suggest that another potential policy objective, equity, is reached by reallocating immigrant students in a Danish lower secondary context. By establishing ethnic mixed classes the educational gap between native students and immigrant students is also reduced. This is due to the fact that relatively many immigrant students are expected to benefit if policy makers limit the share of immigrants to 50 percent. Hence, our results suggest that the educational outcome of immigrant students can be improved on average at essentially no cost to native students, if schools do not have a majority of immigrant students. Another study shows that differences in exam scores of the magnitude found in the present study have substantial impact on the risk of students dropping out of vocational studies (DA, 2006: 49ff).

Another aspect of the policy implications of the findings concerns the question of how to limit the share of immigrants. Reallocating students between schools may have negative side-effects that outweigh the benefits of limiting the share of immigrants at each school. For instance, reallocation may decrease parental involvement (Rikvin, 2000: 341). It is also important to be aware of the fact that it may be costly in terms of human and economic resources to reallocate students, since some students may have to attend a school far away from home.

To sum up, the present study shows how the potential gain of reallocating certain groups of students depends not just on whether average peer group effects exist, but whether such effects are linear or nonlinear. Furthermore, it is shown how asymmetric effects may explain non-linear effects. Finally, the study has demonstrated using Danish register data that only minor efficiency gains are achieved by limiting the share of immigrant students at any school to 50 percent. The analyses, however, suggest that many immigrant students will benefit from limiting the number of schools with 50 percent immigrants or more. Whether these results can be found in other nations with different language and cultural backgrounds is left for further research.

Appendix

[Table A about here]

[Table B about here]

Measuring parental education:

The following shows how parental education is measured in the analysis. Lower secondary schools count as 6 to 10 years depending on the number of years completed. Having completed a secondary education counts as 10 to 13 years depending on the number of years a given secondary education takes.

[Table C about here]

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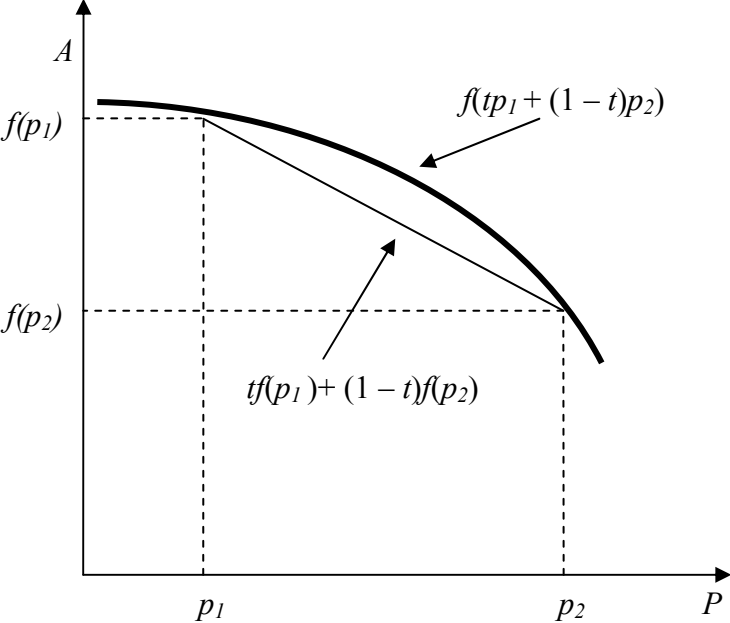
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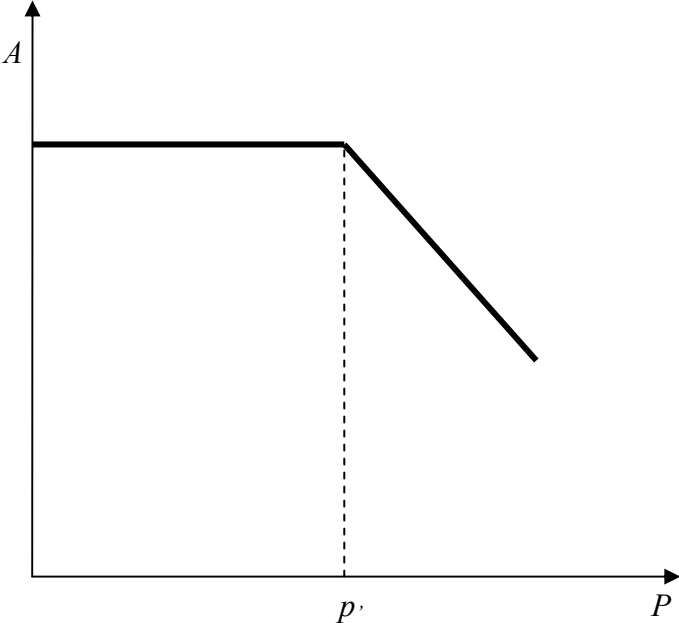
Act no. 1049, 28th of August 2007

Figure 1: Increasing marginal (negative) effect of ethnic concentration



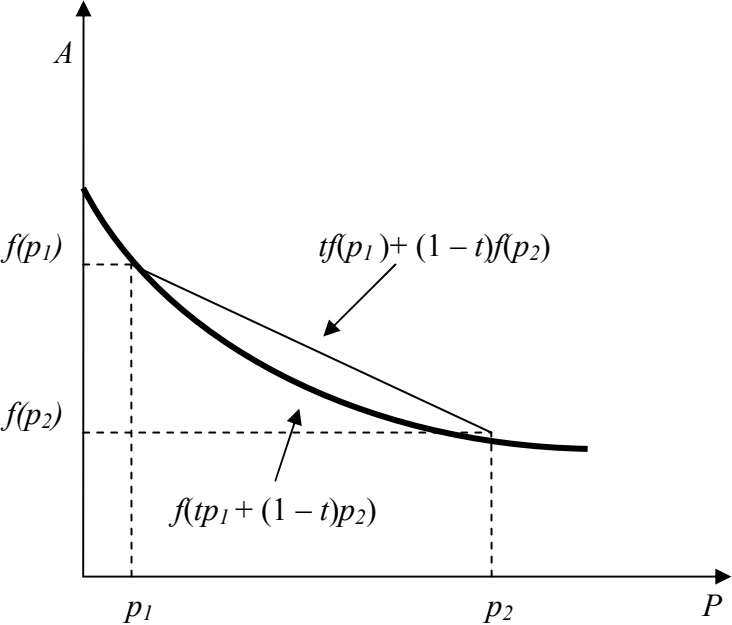
Note: Graphical illustration of a concave function with constantly increasing marginal (negative) effects

Figure 2: Tipping point



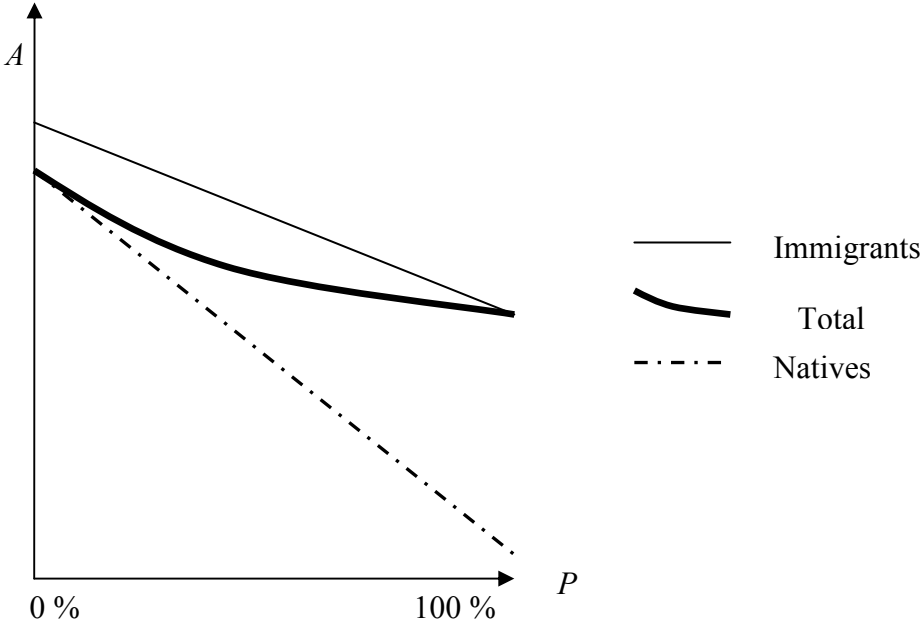
Note: Graphical illustration of a concave function with a tipping point

Figure 3: Decreasing marginal (negative) effect of ethnic concentration



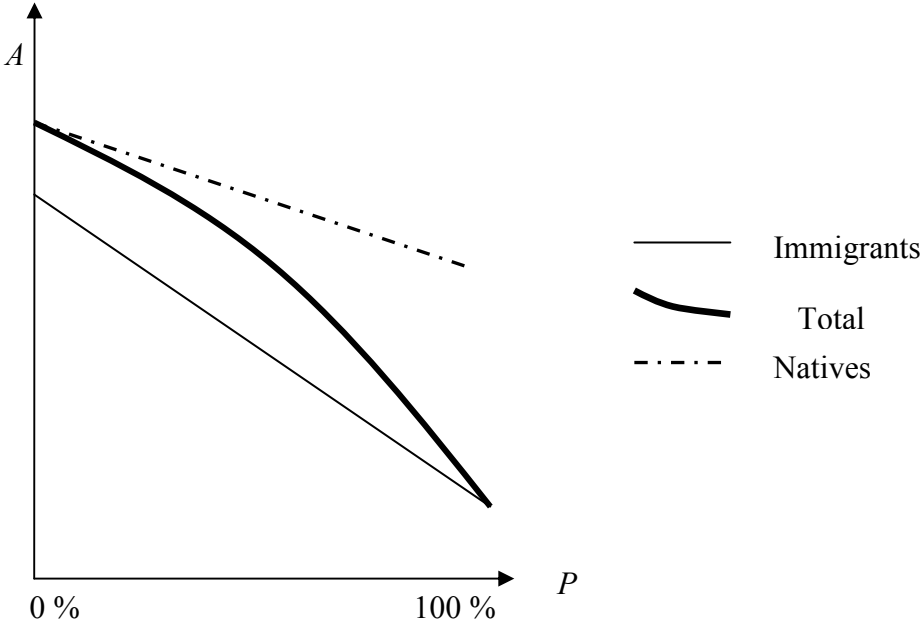
Note: Graphical illustration of a concave function with constantly decreasing marginal (negative) effects

Figure 4: Aggregate effect when peer group effect is less negative for immigrant students



Note: Graphical illustration of asymmetric effects leading to a convex function

Figure 5: Aggregate effect when peer group effect is more negative for immigrant students



Note: Graphical illustration of asymmetric effects leading to a concave function

Table 1 Average ethnic peer group effects in the Danish lower secondary school. OLS and clustered robust standard error.

Ethnic concentration (percent)	-0.004 (0.001)***
Ethnicity	
2nd generation immigrant	-0.307 (0.035)***
1st generation immigrant	-0.533 (0.036)***
Native Danish	-
Gender	
Girl	0.208 (0.012)***
Boy	-
Age	-0.344 (0.016)***
Mother's length of education (years)	0.108 (0.003)***
Father's length of education (years)	0.079 (0.003)***
Mother's gross income (LN)	0.018 (0.005)***
Father's gross income (LN)	0.047 (0.006)***
Mother's capital (10,000 DKK)	0.002 (0.0002)***
Father's capital (10,000 DKK.)	0.0003 (0.000)***
Household	
Live with mother/father in a new relationship	-0.154 (0.031)***
Live with single mother or father	-0.161 (0.016)***
Other	-0.130 (0.031)***
Live with both parents	-
Size of residence (m ²)	0.0001 (0.0001)
Type of residence	
Owned	-0.002 (0.015)
Rented	-
School size	0.0002 (0.000)***
Expenditure per student in the public school in the municipality (10,000 DKK)	-0.030 (0.020)
Share of private school students in the municipality	-0.004 (0.002)**
Average class size in the municipality	-0.0003 (0.008)
Inhabitants in the municipality (10,000)	-0.0002 (0.001)
Taxation base in the municipality (10,000 DKK)	-0.007 (0.014)
Constant	9.775 (0.001)***
R ²	0.220
N _{student}	40,354
N _{school}	1,020

Notes: †Measured by the average grade in written Danish and mathematics. ***significant at 0.01 level, **significant at 0.05 level, *significant at 0.10 level (OLS-estimation with clustered robust standard error in parentheses). Included in the model are six indicator variables. The result for the variables is not included in the table. Schools with less than 10 students are also excluded.

Table 2 Non-linear ethnic peer group effects in the Danish lower secondary school. OLS with clustered robust standard error.

	Model 1	Model 2	Model 3	Model 4
Ethnic concentration				
0-9.99 percent	-	-	-	-
10-19.99 percent	-0.125 (0.031)***	-0.039 (0.031)	-0.025 (0.023)	-0.018 (0.024)
20-29.99 percent	-0.335 (0.049)***	-0.156 (0.050)***	-0.091 (0.040)**	-0.075 (0.040)*
30-39.99percent	-0.487 (0.076)***	-0.204 (0.079)***	-0.102 (0.070)	-0.062 (0.067)
40-49.99 percent	-0.681 (0.086)***	-0.331 (0.085)***	-0.138 (0.082)*	-0.093 (0.084)
50-59.99 percent	-0.920 (0.107)***	-0.486 (0.123)***	-0.276 (0.109)**	-0.222 (0.109)**
60-69.99 percent	-0.980 (0.151)***	-0.444 (0.145)***	-0.253 (0.141)*	-0.195 (0.134)
70-79.99 percent	-1.257 (0.140)***	-0.613 (0.147)***	-0.419 (0.125)***	-0.332 (0.126)***
80-100 percent	-1.633 (0.172)***	-0.907 (0.172)***	-0.634 (0.150)***	-0.569 (0.163)***
Individual characteristics		X	X	X
Family background			X	X
School characteristics				X
Municipality characteristics				X
Constant	7.997 (0.015)***	14.251 (0.244)***	9.482 (0.111)***	9.533 (0.332)***
R ²	0.033	0.095	0.219	0.220
N _{student}	40,354	40,354	40,354	40,354
N _{school}	1,020	1,020	1,020	1,020

Notes: †Measured by the average grade in written Danish and mathematics. ***significant at 0.01 level, **significant at 0.05 level, *significant at 0.10 level (clustered robust standard error in parentheses).

Figure 6: Ethnic peer group effects in different shares of immigrants

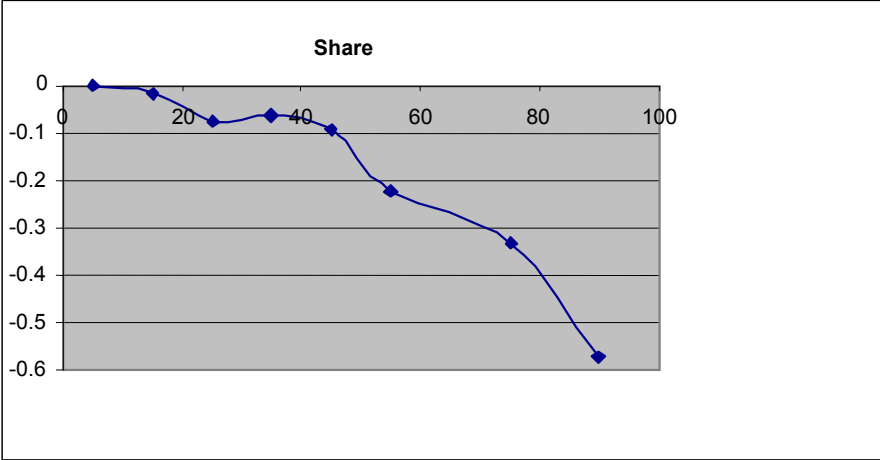


Table 3 Asymmetric ethnic peer group effects in the Danish lower secondary school. OLS regression and clustered robust standard error.

	Native Danish students	Immigrant students
Ethnic concentration	-0.0035 (0.001)***	-0.0060 (0.002)***
Individual characteristics	X	X
Family background	X	X
School characteristics	X	X
Municipality characteristics	X	X
Constant	9.950 (0.353)***	12.768 (1.055)***
R ²	0.174	0.147
N _{student}	36,427	3,927
N _{school}	1,017	788

Notes: ¹Measured by the average grade in written Danish and mathematics. ***significant at 0.01 level, **significant at 0.05 level, *significant at 0.10 level (clustered robust standard error in parentheses).

Table 4: Tipping point for native Danish students and immigrant student in the Danish lower secondary school. OLS and clustered robust standard error.

	Native Danish students	Immigrant students
Ethnic concentration		
0-9.99 percent	-	-
10-19.99 percent	-0.0234 (0.0238)	-0.0142 (0.0659)
20-29.99 percent	-0.0714 (0.0408)*	-0.1357 (0.0815)*
30-39.99percent	0.0101 (0.0735)	-0.1910 (0.1041)*
40-49.99 percent	-0.1354 (0.0918)	-0.0477 (0.1171)
50-59.99 percent	-0.3369 (0.1619)**	-0.1575 (0.1696)
60-69.99 percent	-0.2569 (0.1572)	-0.1818 (0.1656)
70-79.99 percent	-0.4048 (0.2372)*	-0.3096 (0.1579)*
80-100 percent	-0.2126 (0.2369)	-0.6681 (0.2043)***
Individual characteristics	X	X
Family background	X	X
School characteristics	X	X
Municipality characteristics	X	X
Constant	9.2383 (0.3519)***	13.0913 (0.8752)***
R ²	0.1746	0.1496
N _{student}	36,427	3,927
N _{school}	1,017	788

Notes: †Measured by the average grade in written Danish and mathematics. ***significant at 0.01 level, **significant at 0.05 level, *significant at 0.10 level (clustered robust standard error in parentheses).

Table A: Summary statistics

Variable	N	Average	SD ¹	Minimum	Maximum
Dependent variable:					
Average grade in written Danish and mathematics	43,406	7.87	1.29	1.50	13
Explanatory variable:					
Percentage of immigrant students at 9th grade (percent)	44,743	10.03	14.12	0	100
Individual characteristics					
Gender (girl = 1, boy = 0)	44,743	0.50	-	0	1
Ethnicity:					
Native Danish	44,743	0.89	-	0	1
1st. generation immigrant	44,743	0.05	-	0	1
2nd generation immigrant	44,743	0.05	-	0	1
Age	44,735	14.12	0.43	12	18
Family characteristics					
Mother's length of education (years)	43,085	12.63	2.63	6	20
Father's length of education (years)	41,566	12.59	2.63	6	20
Mother's gross income (Ln)	44,135	12.18	1.27	0	15.65
Father's gross income (Ln)	42,444	12.56	1.08	0	16.27
Mother's capital (10,000 DDK)	44,270	11.01	60.16	-646.23	6,500
Father's capital (10,000 DDK)	42,861	18.62	132.01	-5,876.53	12,913
Type of residence (owned = 1, rented = 0)	44,490	0.80	-	0	1
Size of residence (m ²)	44,743	75.10	40.95	0	3,519
Household:					
Live with mother/father in a new relationship	44,510	0.04	-	0	1
Live with single mother or father	44,510	0.19	-	0	1
Live with both parents	44,510	0.73	-	0	1
Others	44,510	0.04	-	0	1
School characteristics					
Size of school	43,490	507.71	161.55	32	935
Expenditure per student in the public school in the municipality (10,000 DKK)	41,985	5.37	0.55	4.19	7.79
Share of private school students in the municipality	41,985	12.64	6.68	0	36.7
Average class size in the municipality	41,985	20.16	1.32	15.1	23.2
Municipality characteristics					
Inhabitants in the municipality (10,000)	41,985	7.51	12.15	0.21	50.24
Taxation base in the municipality (10,000 DDK)	41,985	14.16	0.82	12.94	16.59
Number of students	44,743				
Number of schools	1,020				

Notes: Included in the model are six indicator variables. The result for the variables is not included in the table. Excluded from the analysis are students attending 9th grade in a private school, taking 10th grade. Schools with less than 10 students are also excluded.

¹ Standard deviation.

Table B: Average percentage of bilingual students in the Danish lower secondary school in selected Danish municipalities

Name of the municipality	Average percentage of bilingual students in the lower secondary schools in the municipality	Minimum	Maximum
101 Copenhagen	32.3	0.2	92.6
147 Frederiksberg	17.3	2.0	90.8
151 Ballerup	11.2	1	100
153 Brøndby	34.8	6.8	76.0
159 Gladsaxe	11.5	0.4	44.6
161 Glostrup	15.9	7.1	35.2
163 Herlev	17.8	10.4	36.7
165 Albertslund	25.4	21.9	39.4
167 Hvidovre	15.4	2.7	59.4
169 Høje-Tåstrup	21.5	1.9	94.6
175 Rødovre	15.6	2.1	29.9
183 Ishøj	38.4	2.4	93.8
205 Birkerød	11.6	1.3	12.8
207 Farum	15.9	5.3	22.1
211 Frederiksværk	10.1	3.3	12.7
217 Helsingør	13.1	0.1	100
227 Karlebo	21.6	20.1	41.7
253 Greve	12.7	0.2	87.5
259 Køge	12.4	1.8	34.5
265 Roskilde	10.7	1.1	100
329 Ringsted	11.7	0.6	30.1
333 Slagelse	16.3	0.5	59
367 Nakskov	13.3	2.3	22.6
461 Odense	16.0	0.7	100
537 Sønderborg	18.7	8.9	44
545 Åbenrå	10.8	1.7	38.4
561 Esbjerg	13.3	0.8	69.6
615 Horsens	10.8	0.6	50.7
631 Vejle	11.3	0.5	47.6

663 Ikast	10.8	0.9	21.4
751 Århus	17.6	0.3	100
851 Aalborg	11.3	0.7	48.3

Source: Ministry of Education, school year 2004/2005.

Note: Only municipalities where at least 10 percent of the students are bilingual are included.

Table C: Measuring parental education

Parental education	Length of education	Value
Lower secondary school	Between 6 and 10 years	Between 6 and 10 depending on the number of years in lower secondary school
Upper secondary school – academic track	3 years	9 years of secondary school + 3 years of upper secondary school = 12
Upper secondary school – vocational track	Between 1 and 4 years	9 years of secondary school + between 1 to 4 years of upper secondary school = between 10 and 13
Short further education ¹	Between 1 and 2 years	9 years of secondary school + 3 years of upper secondary school + length of short further education = between 13 and 14
Long further education	Between 2 and 4 years	9 years of secondary school + 3 years of upper secondary school + length of long further education = between 13 and 16
Higher education	5 years	9 years of secondary school + 3 years of upper secondary school + higher education = 17
PhD	8 years	9 years of secondary school + 3 years of upper secondary school + length of PhD = 20

Notes

¹ Similarly it can be shown mathematically that if either one or both peer effects on each of the two groups are quadratic and asymmetric the total relationship will – in all practical cases – be non-linear.

² For more complex functions with different local maxima and minima, one can use a concave envelope function to show at what distribution total achievement is maximised. The mathematical description is not presented here.

³ The following grades can be given: 00, 03, 5, 6, 7, 8, 9, 10, 11, and 13. On the European Credit Transfer System, 00 and 03 corresponds to F, 5 to Fx, 6 to E, 7 to D, 8 to C (average performance), 9 to B, 10 to B+, and 11 and 13 to A.

⁴ For more information about how this variable is measured see Appendix C.

⁵ To check the robustness of the OLS model, we use an instrumental variable (IV) approach. We use the percentages of bilingual children within upper secondary school in each municipality as an IV. Tests show that the IV (1) correlate with the potentially endogenous explanatory variable, and (2) is not correlated with unobserved variables which affects the dependent variable, as required (see Wooldridge, 2002: 83-84; Bound et al, 1995: 443). We also believe that the IV does not correlate with unobserved variables such as parental engagement and parental ambitions, which is a third

assumption related to an IV (*ibid.*). It seems implausible that very engaged and ambitious parents are more likely to settle in a municipality with few bilingual children in upper secondary school, on average, than less ambitious and engaged parents are. Firstly, job and family relations are more important determinants when it comes to choosing in which municipality to settle down. Secondly, living in a municipality with a high percentage of bilingual children in upper secondary schools does not necessarily cause one's child to attend a school with high ethnic concentration. As shown in table B in the Appendix the minimum share of immigrant students in the schools within each municipality is rather low. In other words, it is possible for engaged and ambitious parents to avoid schools with high ethnic concentration by sorting between schools and/or residential areas within a municipality. Furthermore, since we use detailed control variables in our analysis, the question becomes whether a family with a given income, education etc. living in one municipality is likely to be more engaged in their children than a family with the same characteristics living in another municipality (see Feinstein & Symons, 1999: 307).

⁶ The IV estimate for ethnic concentration is -0.005 , and a Hausman test (see Wooldridge, 2002: 120) shows that the difference in magnitude between the OLS estimate and IV estimate for ethnic concentration is not significant (P-value = 0.453). Similar parameter estimates for ethnic concentration when using the IV method and the OLS method indicates that the observed control variables effectively capture the effect of the former mentioned unobserved control variables and thereby reduce the omitted variables bias. Thus the robustness check confirms that control variables of the OLS-model effectively control for potential endogeneity.

⁷ The control variable estimates are not presented here, but can be requested from the authors.