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AN ANALYSIS OF THE ASSOCIATION BETWEEN SOCIOECONOMIC CONTEXT, GENDER, AND ACHIEVEMENT

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The purpose of the study described in this paper was to investigate the existence of a social context effect, that is, the hypothesis that student achievement is negatively affected by the presence of increasing densities of students from disadvantaged backgrounds. The study used achievement data extracted from national assessments of reading in 1998 and Mathematics in 1999 at primary level, and Junior Certificate Examination (JCE) results in English and Mathematics in 1998. Primary-level results were converted to scale scores, and JCE grades to 'performance scores'. The presence or absence of a family medical card was used as a measure of student socioeconomic background. In multilevel models, the contribution of student- and school-level variables to achievement was evaluated while adjusting for the effect of other variables. For each of the datasets, substantial relationships were found between individual achievement and the percentage of students in the school from families which held a medical card, over and above the relationship between achievement and family possession of a medical card. When all three variables (whether the student's family had a medical card, student gender, and the percentage of students in the school from families with a medical card) are included, the models explain between 41.2% and 58.8% of the between-school variance components (comprising 17% and 25-27% of the total variance in achievement scores at primary and post-primary levels respectively). The fitted values from the models generated from all three datasets suggest that the achievement measures decline in a continual and linear manner as the percentage of students in the school from families holding medical cards increases. The steeper slopes for boys for primary level Mathematics, and for both English and Mathematics at post-primary level, suggest that the impact of social context is greater for boys than for girls. Implications for school-level policies designed to mitigate the effects of disadvantage (particularly those related to the selection of schools for targeted resource allocation) are discussed.

In discussions of policy on educational disadvantage, such as those at the National Education Convention (1994), disagreement sometimes occurs between those who do and do not believe that the overall socioeconomic context or social mix of the school is an important factor affecting pupil achievement. Arguments that the context is important are sometimes framed in terms of a belief that the disadvantage associated with poverty is aggravated when large proportions of pupils in a school are from poor backgrounds. Some support for this belief (sometimes referred to as a 'social context effect') is to be found in the international literature. For example, there is evidence that students from lower socioeconomic status homes do better in schools where they are mixed with students from higher socioeconomic status homes than in schools where most other students also come from lower status homes (Coleman et al, 1966; Driessen & Sleegers, 2000; Patterson, 1991; Thrupp, 1995; Willms, 1986). In one Irish study, Smyth (1999) found that the 'social class mix (average social class) within a school has a significant impact on pupil performance' (p.49) on the Junior and Leaving Certificate examinations, even when pupils' own social class is taken into account. More recently, Sofroniou (2004) found evidence of a context effect that needs to be interpreted in terms of its interaction with gender in a survey of literacy in a sample of schools that had been designated as disadvantaged. Some researchers, however, have failed to find evidence of a context effect (Bondi, 1991; Mortimore, Sammons, Stoll, Lewis, & Ebob, 1988 in the UK; Martin, 1980 in Ireland), while others have raised the possibility that some demonstrated effects may result from methodological weaknesses or misinterpretations of results (Harker & Tymms, 2004; Nash, 2003).

Whether or not social context is important has a number of implications. Thrupp (1999), for example, argued that the idea of social context (or school mix, as he described it) sets limits to what it is reasonable to expect schools to achieve in terms of reform or becoming more effective. He further suggested that school mix 'appears to go to the heart of enduring questions about the impact of unequal access and provision of education as well as to current debates over choice, self-management, accountability, standards and the role of the state in education' (p. 8). These very general implications are not considered in the present paper. However, the paper does focus on the implications of social context for one aspect of the implementation of public policy on educational disadvantage: the most appropriate way of identifying disadvantage with a view to targeting resource allocation.

In a submission to the Minister for Education and Science relating to the identification of disadvantage, the Educational Disadvantage Committee (n.d.) called for research on the social context effect. Evidence for the existence of such an effect would provide a strong argument in favour of a policy of identifying and targeting schools with concentrations of disadvantage. Furthermore, the committee recognized that, if a social context effect was found to exist, one could then investigate whether the relationship between levels of concentration of disadvantage in a school and average achievement in the school was linear or whether there were non-linear discontinuous relationships that could be taken to suggest meaningful thresholds for making decisions about targeted resource allocation. If such thresholds were identified, it might be possible to devise schemes in which schools were assigned to bands based on the thresholds rather than selecting schools on the basis of whether they were above or below a single threshold. Schemes for addressing educational disadvantage, such as the Designated Areas Scheme (DAS), Breaking the Cycle (BTC), and important aspects of Giving Children an Even Break (GCEB), used the latter approach insofar as they admitted schools to the scheme if they were above a single threshold which was, in effect, the point at which resources were exhausted. Some of the problems associated with this approach have been considered by Weir and Archer (2004).[1]

Failure to find evidence of a social context effect would strengthen the position of those who argue for the exclusive targeting of individual children (or their families) rather than schools. Furthermore, students from a disadvantaged background would be expected to need the same level of support whether they attended a school with many or few children from a similar background.

Although the possession of a medical card is not synonymous with poverty, the vast majority of families with school-going children that hold medical cards do so because of low income. Furthermore, it was known from previous studies that a strong association existed between individual level achievement and family possession of a medical card. For example, Cosgrove et al (2000) found that pupils in the National Assessment of English Reading (NAER) whose parents possessed a medical card scored, on average, about seven-tenths of a standard deviation below students whose families did not possess a card. We set out to go beyond this finding to determine if concentrations of medical cards had an additional effect on (or, at least, an association with) achievement over and above individual medical card status and, if so, whether the relationship could be regarded as linear. In view of earlier findings (Sofroniou, 2004), we were also interested in the possibility of an interaction between medical card possession and pupil gender.

[1] Descriptions of the various schemes can be found on the Social Inclusion page of the website of the Department of Education and Science, *www.education.ie.* Archer and Weir (2004) provide an account of evaluations of these schemes.

METHOD

Analyses are based on data in three databases. Two relate to primary schools: the 1998 National Assessment of English Reading (NAER) with a sample of 3,696 fifth class pupils in 148 primary schools (Cosgrove, Kellaghan, Forde, & Morgan, 2000) and the 1999 National Assessment of Mathematics Achievement (NAMA) with a sample of 4,402 fourth class pupils in 119 primary schools (Shiel & Kelly, 2001). In both cases, test data were scaled using item response modelling and yielded a scale with a mean of 250 and a standard deviation of 50. At post-primary level, a new database was developed with the help of the Information Technology Unit of the Department of Education and Science and the State Examinations Commission. It contains students' 1998 Junior Certificate Examination (JCE) grades in English and mathematics and the syllabus levels at which they took these examinations, their gender, and whether their family had a medical card (based on information about examination fee waivers) but with all identifying information suppressed (over 63,000 students in 738 schools).[2] For the analyses reported here, numerical values were assigned to examination grades using a procedure devised for previous research on examination results (e.g., Kellaghan & Dwan, 1995). The resultant scale has a range of values from 0 to 12. Thus, each of the three databases contains a measure of each student's achievement and gender and an indication of whether or not his/her family possessed a medical card. Overall percentage medical card possession at school level was also calculated and was used as a measure of social context.

Multilevel regression models (see e.g., Goldstein, 1995; Hox, 2002; Longford, 1993) were used to develop explanatory models of achievement (see also Sofroniou, 2004 for a description of the method in the context of schools that are designated as disadvantaged). These take into account the clustered nature of the observations by fitting a school-specific random effect distribution:

$$\text{student score} = \beta' x + \sigma z_j \quad \text{(with Normal residual variance)}$$

where schools are denoted by j, the random effect (intercept) is z ~ standard Normal (0,1) multiplied by σ estimated as a parameter, the explanatory variables are represented by x and a vector of parameter estimates by β'. These models were fitted using maximum likelihood estimation in the R software

[2] A database with these variables apart from gender, aggregated to school level was used to develop an index of disadvantage for post-primary schools as part of what was known as the 16:1 initiative (see Weir & Archer, 2004).

package with the NLME library of Pinheiro and Bates (2000). Terms were retained in a model if their omission led to a significant change in deviance ($p \leq 0.05$) evaluated using the chi-square distribution with df=number of terms omitted. Where an interaction between two variables was required, the corresponding main effects were also included (e.g., β_1 gender + β_2 PercentMedicalCard + β_3 gender×PercentMedicalCard).

RESULTS

The Presence of a Social Context Effect

An observed relationship between a particular variable and student examination performance may be because both are related to a third variable. Since multilevel models allow for an assessment of the contribution of student- and school-level variables to achievement, while adjusting for other variables in the model, one is less likely to make incorrect inferences than when only one variable at a time is considered. The models allow a partitioning of the total variance in scores into between- and within-school components, as well as how much of each is explained by the fitted model.

We began by looking at variance components in our four outcome measures (English reading and mathematics at primary level and JCE English and mathematics) (Table 1). The main focus is on the portion of the variance that is between schools, although, in all four cases, there is far more variance between individuals and classes within schools than between schools. For the two primary school outcome measures, about 17% of total variance is between schools. In the case of the JCE measures, between-school variance represents 25% of total variance in JCE English and 27% in JCE mathematics.

In terms of variation at the school level, the two individual-level variables (gender and whether the student's family had a medical card or not) explains between 22.5% and 29.0% of the between-school variance. In all cases, the addition of the measure of social context (the percentage of students from families with medical cards in the school) to the model brings about a substantial increase in the amount of between-school variance explained (between 18.8% and 29.3%). When all three variables are included, the models explain between 41.2% and 58.8% of between-school variance.

Table 1
Summary of the Partitioning of Achievement Variance and the Percentages of Explained Variances at the School Level

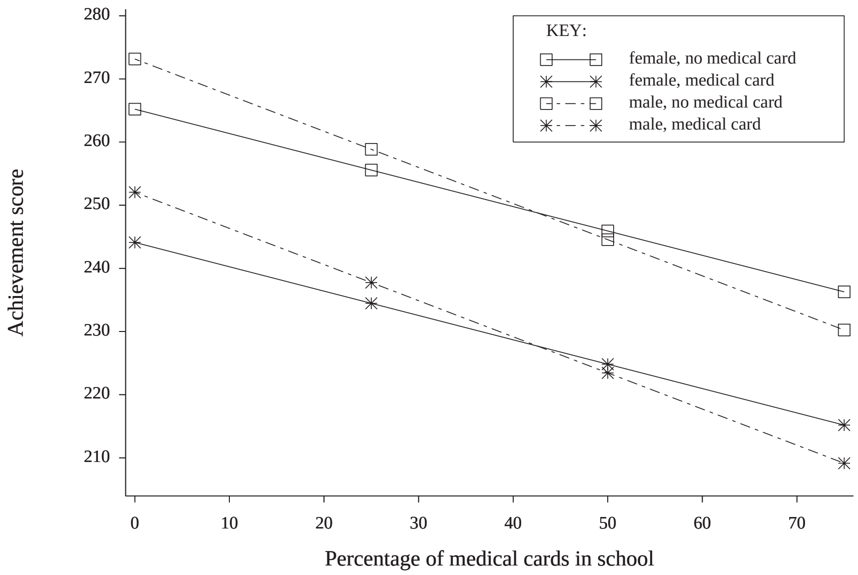
	Primary		Post-Primary	
	English Reading	Mathematics	JCE English	JCE Mathematics
Percentage of total variance that is between clusters (schools)	16.8	17.5	27.2	25.3
Percentage of between-school variance explained by individual family medical card possession and gender	31.7	22.5	29.5	24.9
Additional percentage of between-school variance that is explained by percentage of medical cards in the school	25.3	18.8	29.3	28.7
Total percentage of variance explained by the three variable model	57.0	41.2	58.8	53.0

Although it is not the focus of our study, it is worth recording how the three-variable model fared in terms of explaining within-school (between-individual and between-class) variance. The model explained 14.9% of within-school variance in the case of English reading at primary level, 11.39% in the case of mathematics at primary level, 22.2% in the case of JCE English, and 18.2% in the case of JCE mathematics. This suggests that the models fit the data quite well at the school level, though additional variables would be needed to provide a fuller explanation of individual student variation in achievement.

The Nature of the Social Context Effect

Having demonstrated a social context effect, we can proceed to explore aspects of the nature of the effect (i.e., is the relationship linear, and are there interactions with gender?). Figures 1 to 4 show the relationship, according to the model, between achievement and the density [percentage of students from families with medical cards for four groups of students (females and males from families with and without medical cards)]. The fitted achievement scores are the values expected for a typical student with each combination of gender and individual medical card status in an average school with a given density of students whose families hold medical cards (i.e., the mean of the random intercept was used in combination with the estimated fixed effects for the explanatory variables to generate the fitted scores).

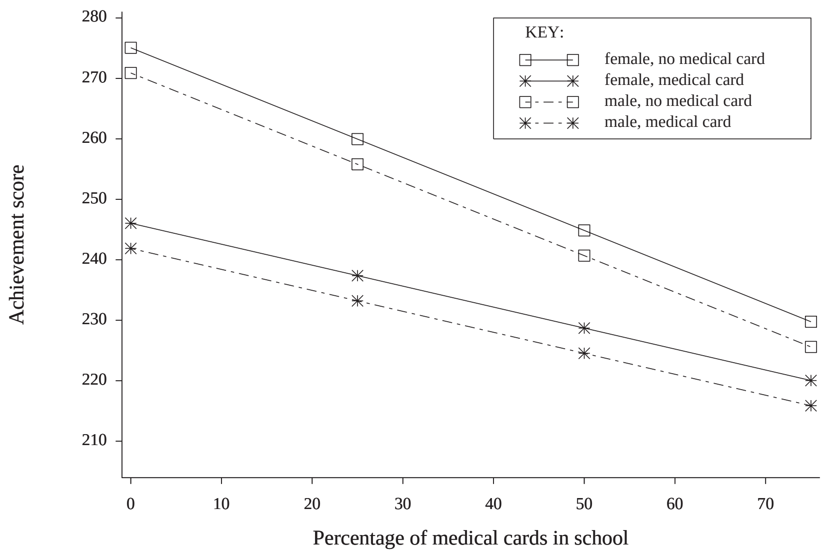
Figure 1
Fitted Scores from the Model of Fourth Class Mathematics for the Variables Gender, Individual Medical Card Status, and Percentage of Students from Families with Medical Cards in a School



For fourth class mathematics, the fitted values in Figure 1 suggest a linear context effect with a steeper slope for males and a constant difference for individual medical card status. The difference between students in a school in which 75% of students came from families with medical cards compared to students in a school with none is 43 points (9/10 *SD*) for males and 28 points (almost 6/10 *SD*) for females. Individuals whose families hold medical cards score on average 21 points (2/5 *SD*) lower than students whose families do not have a medical card. The gender difference favours males in schools with few or no students from families with medical cards (8 points; about 1/6 *SD*) but this becomes a deficit (-6 points; about 1/8 *SD*) in schools in which 75% of students are from families with medical cards. Thus, there is evidence of an interaction between context and student gender for this achievement variable.

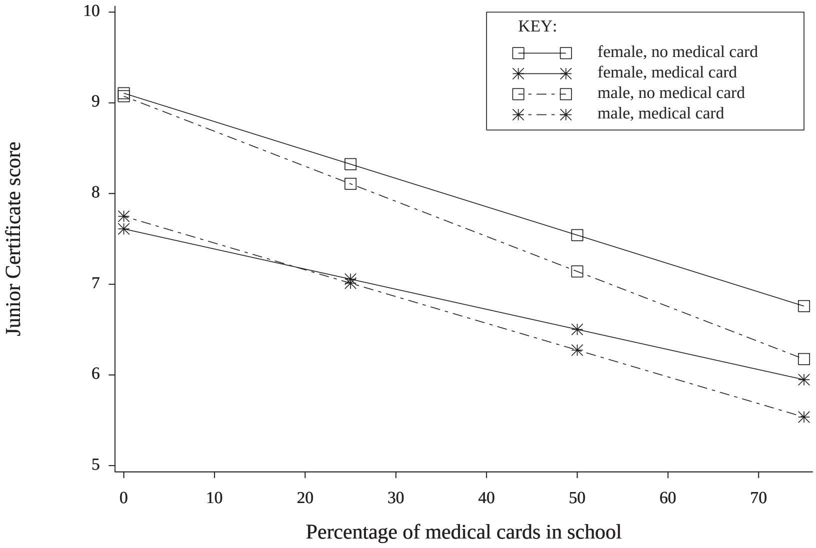
Figure 2

Fitted Scores from the Model of Fifth Class Reading for the Variables Gender, Individual Medical Card Status, and Percentage of Students from Families with Medical Cards in a School



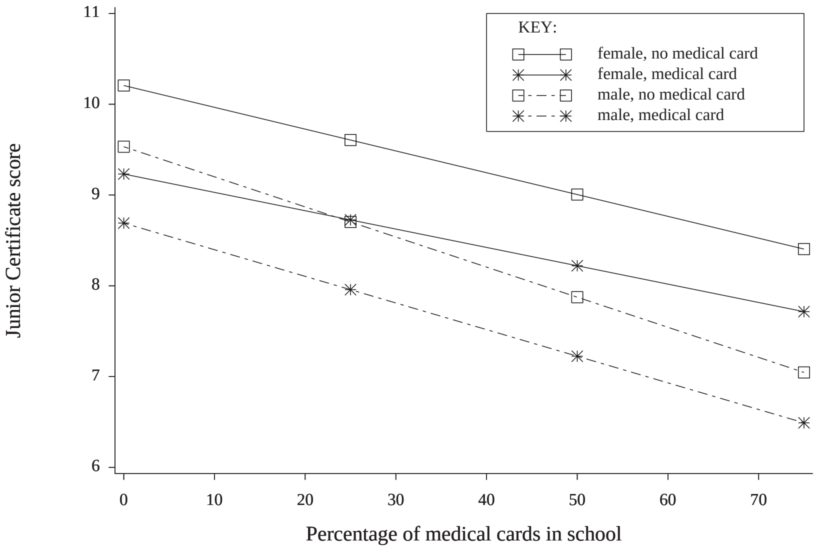
The fitted values for fifth class reading in Figure 2 suggest a linear context deprivation effect with a steeper slope for students from families that do not have a medical card and a constant gender difference. The difference between students in a school in which 75% of students' families hold a medical card compared to students in a school with none is 26 points (1/2 *SD*) for students from medical card families and 45 points (9/10 *SD*) for students from non-medical card families. The difference in favour of students from non-medical card families in schools with very few students from families with medical cards is 29 points (3/5 *SD*), while in schools in which 75% of students were from homes with medical cards the value is 10 points (1/5 *SD*). Females scored, on average, 6 points (almost 1/8 *SD*) higher than males. Thus, in this case, there is no evidence of an interaction between context and gender.

Figure 3
Fitted Scores from the Model of Junior Certificate Examination Mathematics for the Variables Gender, Individual Medical Card Status, and Percentage of Students from Families with Medical Cards in a School



In the case of Junior Certificate Examination mathematics, the fitted values in Figure 3 also indicate a linear context effect with steeper slopes for students from families without medical cards and for males. A gender difference in favour of females appears in schools with high densities of students from families with medical cards. The difference between students in a school in which 75% of students came from families with medical cards and students in a school with none ranges from a deficit of 1.66 grade points (3/4 *SD*) for females from medical card families to a deficit of 2.9 points (1/3 *SD*) for males from families that did not have a medical card. The deficit associated with an individual student from a family that hold a medical card varies between 0.63 grade points (1/3 *SD*) for males in schools in which 75% of students came from families with a medical card and 1.50 grade points (2/3 *SD*) for females in schools in which very few students came from homes with a medical card. Figure 3 reveals an interaction between gender and social context. There is a very small gender difference (in favour of males from families with a medical card) in schools with low densities of students from homes with a medical card. However, a deficit in scores for males is evident by the time the percentage of students from homes with a medical card in the school reaches 75.

Figure 4
Fitted Scores from the Model of Junior Certificate Examination English for the Variables Gender, Individual Medical Card Status, and Percentage of Students from Families with Medical Cards in a School



The fitted values in Figure 4 for the Junior Certificate Examination in English show a linear context effect with a steeper slope for males. A gender difference in favour of females increases in schools with high densities of students from homes with a medical card. The difference between students in a school in which 75% of students came from families with a medical card and students in a school with none ranges from a deficit of 1.51 grade points (4/5 *SD*) for females who also came from homes with a medical card to a deficit of 2.48 points (1 3/10 *SD*) for males who came from homes that do not have a medical card. Thus, there is an interaction between gender and context. The deficit associated with an individual student from a family with a medical card varies from 0.56 grade points (3/10 *SD*) for males in schools with 75% medical card density to 0.98 grade points (1/2 *SD*) for females in schools in which there are very few students from homes with a medical card. The gender difference is in favour of females throughout.

DISCUSSION

The findings presented in this paper provide strong support for the existence of a social context effect in two ways. First, the partitioning of achievement variance (summarized in Table 1) shows that at primary and post-primary levels, and for two domains (English and mathematics), the introduction of a measure of social context brought about a substantial increase in the percentage of variance explained. Thus, the concentration of students from families with medical cards in a school appears to have an effect on achievement over and above the effect of individual medical card status. Second, in the modelling exercise represented in Figures 1 to 4 the fitted values for all four variables present a similar picture. For all four groups (males, females, students from families with medical cards, and students from families without medical cards), the value of the achievement measure declines as the percentage of students from families with medical cards in the school increases.

The findings point to the presence of a social context effect that is more general than the one we formulated earlier (i.e., the disadvantage associated with poverty is aggravated when large proportions of pupils in a school are from poor backgrounds), since students from families that do not have medical cards, as well as students from families with cards, appear to be affected by context. Achievement is higher in schools with few students from families with medical cards for students from both families with and without medical cards, while both groups appear to be disadvantaged by being in schools in which large proportions of students come from families with medical cards. Indeed, in the case of mathematics at least, there is some basis for believing that the impact of context is greater for students whose families do not have a medical card than for students whose families have a card. This inference is based on the fact that the slopes for students from non-medical card families are steeper in the figures for mathematics (Figures 1 and 3).

There is no indication in the data of any qualitative change in the nature of the relationship between social context and outcome. In each case, the relationship between the percentage of students whose families possess a medical card and achievement is adequately fitted by a linear model, implying a steady drop in individual achievement as the density of students in the school from families with medical cards increases.

The impact of social context appears to be more serious for boys than for girls in mathematics. Boys perform better than girls in mathematics in primary schools with low concentrations of students from medical card families, but not as well as girls in schools with high concentrations, as evidenced by the fact that the lines for males and females cross over in Figure 3 at a point corresponding to between 40% and 50% medical card possession. In the case of Junior Certificate Examination mathematics (Figure 3), there is little or no difference between boys and girls at very low concentrations of disadvantage but such differences emerge and become more pronounced as the percentage of students from families with a medical card in the school increases. The fact that the lines for males and females in Figure 4 are parallel indicates the social context effect on English reading (primary) does not interact with gender. However, at post-primary level, the pattern for JCE English is more like the pattern for the two mathematics measures than that for English reading (primary). In Figure 4, the slopes for the two lines for males are steeper than the corresponding ones for females, again indicating a more serious impact of social context on boys than on girls.

In interpreting these findings it should be borne in mind that the models are designed to explain school-level variation reasonably, but that the majority of variation in achievement scores (which is at the individual and class level) is left unexplained by the social context of the school, gender, and individual medical card status of students' families. The fitted score differences usefully reflect the average differences in groups across the population, but are not suitable for predicting an individual student's learning outcome. It should also be noted that only two achievement domains (English and mathematics) were examined.

Evidence of a social context effect provides support for continuation of a policy of identifying and targeting schools with concentrations of disadvantage. However, the fact that we found no evidence of a clear cut-point at which the social context effect 'kicks in', or no point at which the relationship changes qualitatively, has implications for the selection of schools. In particular, it means that we have not identified any basis for placing schools in a small number of bands as had been suggested by the Educational Disadvantage Committee. Because the relationship is best represented as linear, a larger number of bands or, preferably, a sliding scale is indicated. The use of a sliding scale would, of course, deal with some of the problems associated with the use of rigid cut-points to allocate resources (Weir & Archer, 2004).

A sliding scale is already in place in the funding element of the primary level Giving Children an Even Break (GCEB) scheme through the payment of a small supplementary capitation grant for every pupil deemed to be disadvantaged (using an estimate, based on a survey in 2000, of the number of such pupils in the school). It might be worth exploring this approach with a view to using it more extensively at primary and post-primary levels. For example, there might be merit in developing the idea of applying a weighting, based on the level of disadvantage in the school, to the computation of a notional total enrolment for the school (e.g., the actual number of students in the school plus a multiple of the number of students from disadvantaged backgrounds) to establish a school's entitlement to funding. A sliding scale, based on notional enrolment, might also be used to determine a school's level of access to the kinds of external supports that have been identified in the research literature as effective strategies for dealing with disadvantage (e.g., professional development) (e.g., Archer & Weir, 2004). It should be recognized, however, that the use of any kind of sliding scale to calculate schools' entitlements to staffing would present difficulties since most teacher allocation practices at primary and post-primary levels involve the creation of full-time posts based on thresholds of enrolment or pupil-teacher ratio (Department of Education and Science Primary Branch, 2004; Expert Group on the Allocation of Teachers to Second Level Schools, 2001). For example, for the school year 2004-2005, a primary school with an enrolment of 267 pupils is just at the threshold for the employment of ten mainstream class teachers, but its enrolment would have to increase to 296 before it would be entitled to appoint an eleventh teacher. However, a sliding scale could be appropriate in situations where the allocation of teaching hours or part-time posts apply.

The findings of an interaction between gender and social context in three of our four analyses could also have implications for the way levels of disadvantage in schools are assessed and for how such assessments are used to allocate additional resources. The indications that boys are more adversely affected than girls by being in a school with large concentrations of students from disadvantaged backgrounds provide a case for taking account of the gender composition of a school in determining its entitlement to additional resources. The case for this procedure would appear to be particularly strong in situations where levels of educational attainment or achievement are not used in the assessment of levels of disadvantage, as has been the case to date in all assessments of disadvantage in primary schools in Ireland. It could be argued that the use of measures of attainment or achievement to assess disadvantage (as has been the case to a limited extent at post-primary level) would, in itself, result in increased entitlements for schools attended by boys.

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