Ability Heterogeneity in Intergenerational Mobility

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by

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Abstract

A rich data set gives a unique opportunity to study heterogeneity in intergenerational mobility. Here, we explore whether the intergenerational association in education and income is the same for children with different results in a cognitive ability test (the Swedish Military Enlistment test).

Despite an endogenous test score, the argument is that this is the policy relevant case to analyze, i.e. whether children of a certain cognitive ability level are influences by *their* parents' socioeconomic status and not whether they are influenced by some random parent.

The intergenerational associations vary a great deal with the results in the cognitive ability test. The intergenerational association is highest for the middle ability groups and lower for both the higher ability and (particularly) the lower ability groups. The overall conclusion is that adding the cognitive ability dimension to studies of intergenerational mobility contributes new and important insights. For example, since the average child (cognitively speaking) seems to be most receptive to parental influence, intergenerational mobility is primarily increased by targeting the average child.

JEL classification: J24, J62

Key words: Intergenerational associations, education, incomes, cognitive ability, interaction

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1. Introduction

There is a need for new ways of studying intergenerational heterogeneity and the interaction of background factors, since knowledge about these aspects of intergenerational mobility might be crucial for the design of future educational and welfare policies and for attempts to reduce inequalities.

Since children may differ in their reception to parental influence**,** an approach to illuminating heterogeneity in intergenerational mobility is to condition on the child's ability characteristics. The aim of our study is therefore to study whether intergenerational mobility in education and income varies with the child's cognitive ability level.

We do this by using the results of a cognitive ability test, namely the Swedish Military Enlistment test, which virtually every male Swedish citizen takes when turning 18.[4] This large data set (a population sample) gives us a unique possibility to study different parts of both the cognitive ability and the parental-background distributions. Based on the test results, we divide the individuals into different test result ("cognitive ability") groups and estimate the intergenerational mobility (father-son intergenerational association in education and income and mother-son intergenerational association in education) in Sweden for each group.

So far, most of the research on intergenerational mobility has focused on the average mobility parameter and tried to solve the transitory earnings bias and the life-cycle bias (Mazumder, 2005; Böhlmark and Lindquist, 2006; Grawe, 2006; Haider and Solon, 2006; Nilsen et al., 2008).[5]

Apart from this there are studies that indicate the existence of heterogeneity and non-linearity in intergenerational mobility, and that intergenerational mobility does vary across the distribution of parental earnings (Peters, 1992; Dearden et al., 1997; Couch and Lillard, 1998; Corak and Heisz, 1999; Eide and Showalter, 1999; Grawe, 2004a;

[4] Since it is (primarily) only males who enlist in the military in Sweden, the study is restricted to sons. The Enlistment test has been shown to have a large explanatory power and has formerly been used for explaining differences in returns to schooling (Nordin, 2008) and differences in labour market outcomes between natives and second generation immigrants (Nordin and Rooth, 2009). The test is discussed more in the data section 2.2 below.

[5] See Corak (2004) for an introduction to and overview of the research on intergenerational mobility.

Bratsberg et al., 2007).[6] For example, Corak and Heisz (1999) find, using a nonparametric method, that the intergenerational mobility in Canada is greater at the lower end of the parental income distribution than at the upper end. For intermediate parts of the distribution the intergenerational mobility follows a V-shape. Studies based on transition matrices (Peters, 1992; Dearden et al., 1997; Corak and Heisz, 1999) report less mobility at the top and at the bottom of the parental income distribution.[7]

The underlying (implicit) assumption in the intergenerational transmission literature is that an equal opportunities economy is one where the expected earnings of the child are independent of parental earnings (Grawe, 2004b). But as Roemer (2004) points out, equal opportunities are fundamentally unrealizable because a child's ability is partly genetically determined.[8] There is clearly a connection between the question we try to illuminate in our study and the scientific literature that has tried to disentangle the influence from nature and nurture in children´s future earnings (Taubman, 1976; Sacerdote, 2002; Plug and Vijverberg, 2003, 2005; Plug, 2004, Björklund et al., 2005; Björklund et al., 2006). However, to disentangle the influence from nature and nurture is in reality an infeasible task since the individual is formed in the interaction between the two factors (Björklund et al., 2006; Turkheimer et al., 2003). With his "skill begets skill" assumption, Heckman has continuously stressed this fact (see e.g. Cunha et al., 2005). Turkheimer et al. (2003) acknowledge this and find, using a twin setting, that IQ is determined in the interaction between genes and environment.[9]

Against this background our approach is innovative since it investigates intergenerational mobility *given* a child's cognitive ability (at around age 18). However, because of parental influences and genetics, the son's cognitive ability ("IQ") is

[6] Credit constraints are often assumed to be the explanation behind non-linearities in intergenerational mobility (Corak and Heisz, 1999). However, when estimating quantile regressions Grawe (2004a) finds no earnings persistence for the group likely to be most sensitive to borrowing constraints, namely high-ability sons born to low-earning fathers. He therefore concludes that binding credit constraints is not a likely candidate when it comes to explaining non-linearities.

[7] However, when making use of transition matrices, part of the non-linearity might be due to the existence of floors and ceilings, i.e. upward mobility is not possible for those at the top of the parental earnings distribution and downward mobility is not possible for those at the bottom of the distribution.

[8] Roemer (2004) also argues that transmission, due to "formation of preferences and aspirations in children", lies outside the equal opportunity concept most people endorse.

[9] They find shared environment to account for 60 percent of the variation in IQ for twins from a low socioeconomic background, whereas the variation in IQ coming from genes is almost zero. On the other hand, for twins from a high socioeconomic background genes are the more important factor for explaining variation in IQ, and shared environment is almost unimportant.

endogenous.[10] Nonetheless, as high (low) ability sons are generally raised by (low) high ability parents this is still the policy relevant case to analyze. That is, we analyze whether children of a certain cognitive ability level are influenced by *their* parents' socioeconomic status and not whether they are influenced by some random parent.[11] Measuring cognitive ability at a younger age would of course be better, but in general nurturing should not change the ranking of children so much as it increases the innate ability differences.

From the above perspectives the endogeneity problem cannot be solved, but it can at least be addressed. Thus, by parental-background adjusting the test result, we analyze heterogeneity in intergenerational mobility from an *expected* ability perspective. With a parental-background adjusted test result we measure whether the son performs higher/lower on the Enlistment test in relation to what is expected for an individual with a certain parental-background. This implies that we study if children deviating from their expected cognitive ability level differ in intergenerational mobility compared to those who score in accordance with parental-background expectations.

This paper finds that the associations, (especially education) are clearly non-linear, highest for the middle ability groups and lower for both the higher ability and (particularly) lower ability groups. To equalize opportunities, the policy recommendation of this exploration is therefore contra intuitive; to increase intergenerational mobility, one should target the average child rather than, cognitively speaking, weak children.

First, in section 2 of the paper we present the data (including a more detailed discussion of the Swedish Enlistment test) and provide descriptive statistics. Section 3 contains our analysis of intergenerational transmission and cognitive ability undertaken in several steps. Besides the main aim; i.e. to ascertaining whether intergenerational mobility in education and income varies with the child's cognitive ability level, we also investigate nonlinearities in intergenerational mobility and address the endogeneity problem (discussed earlier). Section 4 discusses the findings and concludes the paper.

2. Data and descriptive statistics

[10] See Blanden et al. (2007) who focus on the transmission mechanism in intergenerational mobility.

[11] For instance, it would, be preferable to use adopted children (who do not share genetics with the adoptiveparents), but it creates a false randomization.

2.1 The sample

Our empirical analysis uses register data from Statistics Sweden (SCB). The data is a full sample of every individual in the age group 29-38, living in Sweden in the year 2003. The dependent variables, child's educational attainment and child's income, are those measured in 2003. Some other important variables are collected from the 1999 population data, e.g. the Swedish Military Enlistment test and the parental education level (and earnings), and therefore the individuals also have to have lived in Sweden for the year 1999. The data is merged with data from the Swedish National Service Administration ("Pliktverket" in Swedish). The sample used in the analysis contains only male Swedish-born individuals with Swedish- born parents, i.e. 458,884 males. Since only a small and unrepresentative sample of women enlist in the military we are restricted to studying only sons. About 5 percent of the individuals are excluded because enlistment data is missing.[12] The sample then includes 434,420 individuals.

In intergenerational mobility studies it is important that both the child's and the parents' socioeconomic variables are correctly measured.

The intergenerational association in education might be underestimated if the final education level is not used. Since parental educational attainment is measured in 1999 when most parents (93 percent) are between 50 and 70 years old, we are confident that the parental educational attainment is the final education level. Still, we lose 68,384 individuals because either the father's or the mother's education level is missing, which probably implies that we exclude a larger share of less able individuals. But as the test score groups are constructed from the entire population and the intergenerational associations are linear (as section 3.3 shows), this should not affect the results of the study.

The sons' educational attainment measure, SUN 2000, is for the year 2003.[13] Most sons in our age group, 29-38, can be assumed to have finished their education.

[12] 9 individuals are excluded because the age of either the mother or the father is missing.

[13] The measure is a revision of the former SUN classification adjusted to fit the International Standard Classification of Education (ISCED97). From this measure we construct a year of schooling variable that contains every year of schooling (except nineteen years of schooling) between nine, i.e. completing compulsory school, to twenty, i.e. getting a doctoral degree. The parents' education level is based on the former SUN code, which implies that their years of schooling take the values 9, 11, 12, 14, 16 and 18.

When it comes to earnings, the transitory earnings bias and the life-cycle bias could imply that the intergenerational association in earnings is underestimated (Grawe, 2006). Thus, the use of an average of several yearly observations of the parents' earnings is recommended to keep the transitory earnings bias small (Solon, 1999). Therefore, we have computed the father's average earnings[14] for the years 1970, 1975 and 1980 (all earnings are in 1980 prices).[15] According to Mazumder (2005) a "window" of 5 years, which is what has usually been used, is too small. So our window of 11 years is probably sufficient. Moreover, because children with lower cognitive ability may have a father with a more volatile income, we weight the intergenerational association in earnings with the signal-to-noise ratio for each test score group.

Also, the father's and the son's incomes should be measured when the life-cycle bias is small. The earnings measure used for the sons is annual income from work (income from work including short-term sickness benefits) for the year 2003. Böhlmark and Lindquist (2006) have shown that current income seems to capture lifetime income for Swedish men around the age of 34. Since our sons are in the age group 29-38, and the average age of the fathers for the years 1970, 1975 and 1980 (the three years used to measure the income of the fathers) is 34,[16] it means that the life-cycle bias should be only a minor problem and therefore not expected to bias our estimates. The age of the sons ranged between zero and fifteen when the fathers' incomes were measured. Since the labor supply of the mothers might be low during this part of their life (child-bearing age), we do not study the mother-son intergenerational association in income.

Finally, 34,661 sons who have an annual income from work below SEK 10,000 (about US $ 1,500)[17] are excluded and so are 229 individuals with own education missing. This leaves us with a sample of 330,911 individuals.

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[14] The earnings of the father, is collected from the Swedish Population Census (Folk- och bostadsräkningen), and include income from work and self-employment, short-term sickness and parental-leave benefits and study grants.

[15] If any of the earnings for the three years are zero, an average of the remaining positive earnings is computed. By requiring the father's income to be positive, we lose another 235 individuals.

[16] The average age of the fathers is calculated using only those age observations for which earnings are positive.

[17] This amounts to 9.5 percent of the sample (of these 8 percent have zero income). A similar restriction is made in Björklund et al. (2006).

2.2 The Swedish Military Enlistment test

Besides a small number with legitimate health reasons, every male Swedish citizen has to enlist in the military. The person enlists in the year when turning 18, which is either during the second half of the eleventh year of schooling or the first half of the twelfth year of schooling.[18]

The result of the Swedish Military Enlistment test is intended to measure cognitive ability. The test includes four subtests: Instructions, Synonyms, Metal Folding and Technical Comprehension. The Instructions and the Synonyms tests capture verbal ability. The Instructions test also measures the individual's ability to make inductions. Metal Folding is a spatial test, and the fourth test measures technical comprehension. Each test is normalized into a nine-point scale. Using factor analysis, the four tests are transformed into the general intelligence factor, G, which is a nine point stanine scale with mean 5 and a standard deviation of 2.[19] Using G or the sum of the actual test scores makes little difference to our results.

An advantage of the Swedish Military Enlistment test is that the test results, unlike achievement test scores generally, do not seem to need to be age- and schooling-adjusted before use (Neal and Johnson, 1996; Winship and Korenman, 1997; Hansen et al., 2004). It does not need to be age-adjusted since almost everyone takes it at the same age, and the small variation in schooling level when taking the test (those who do not continue to senior high school have a lower education level) does not seem to create endogeneity problems (Nordin, 2008; Nordin and Rooth, 2009).

But what does the Enlistment test actually measure? In contrast to IQ, the result of achievement tests is determined both by cognitive ability and by non-cognitive abilities (Bowles and Gintis, 2002; Cunha et al., 2005; Borghans et al. 2008). For instance, motivation, anxiety and persistence matter for the result of achievement tests.[20] Moreover, empirical evidence indicates that environmental factors and parental abilities influence non-cognitive abilities (Heckman, 2000, Blanden et al., 2007). There is

[18] However, random delays and illness on the test date (in most cases this means that the individual enlists at the beginning of the next year, i.e. still during upper-secondary school) imply that around 17 percent enlist when turning 19 (Guttormsson, 2001).

[19] For more information about the G factor, see Carroll (1993).

[20] There is also substantial evidence that non-cognitive skills do have a direct effect on both educational attainment and income (Bowles et al., 2001; Blanden, et al., 2007).

therefore reason to believe that parental abilities, through their influence on non-cognitive abilities, do affect the sons' results on the Enlistment test.

2.3 Descriptive statistics

Summary statistics for the sons and parents are given in Table 1. The descriptives show that the age of the sons on average is 33.4 years and that their average years of schooling amounts to 12.4. The mean test score is higher than the expected 5, since our restrictions have a tendency to exclude less able individuals. The fathers and the mothers have an equally high average education level, 11.3, but the fathers arre on average 2.5 years older than the mothers in the son's year of birth. Table 2 reveals that the education level of the parents as well as the income of the fathers increase with the sons' Enlistment test result. Moreover, having a test score above four implies that the (absolute) increase in the parental-background variables tends to get larger.

[Table 1 about here]

[Table 2 about here]

3. Results

In this section we report the results from our estimations. First, for comparative purposes, we estimate the conventional intergenerational associations in education and earnings for our sample of sons. Second, the associations are estimated when controlling for the result in the Enlistment test and for the interaction between parental-background (father's and mother's education and father's income) and the test score. Then follows the main results of our study, namely whether the intergenerational associations vary over the sons' test score distribution. In connection with this, we also analyze non-linearities in the intergenerational associations. Finally, we re-estimate the results, now using a parental-background adjusted test score.

3.1 Baseline results

Table 3 contains the intergenerational associations in education (upper panel) and income (lower panel).[21] Column 1 shows the father-son intergenerational association in education to be **.30** and the corresponding association for mother-son to be .29, i.e. of the same size.

[21] We control for son's age and mother's and father's age at son's birth.

The lower panel (column 1) shows that the father-son intergenerational association in income is smaller; it amounts to .19. These associations are, roughly, of the same size as those that other Swedish studies have reported (see, for example, Björklund et al., 2005).

[Table 3 about here]

Next, we start introducing the results of the Enlistment test into our estimations. Column 3 reports the results from estimating how much of the variation in the sons' education and earnings outcomes can be explained by the test scores. The correlation between the result of the enlistment test and the sons' outcomes turns out to be .58 for education and .06 for earnings. This means that the test score largely outdoes the parents' educational level in explaining the sons' educational outcome; the R^2-value is 15-17 percentage points higher in column 3 (when controlling for the test score) than in column 1 and 2 (when controlling for parental education). But when it comes to the sons' earnings outcomes, the explained variation (the R^2-value) is almost as low (around 6 percent) when controlling for the test score (column 3) as when controlling for the fathers' income (column 1). Thus, the test score is a stronger predictor of educational attainment than income.

When we include both parental-background variables and the test score in the same model (column 4 for fathers and column 5 for mothers), the intergenerational associations decrease. The intergenerational associations in education show a very large decrease, about 40 percent, in both the case of father's and mother's education. The father-son association in earnings decreases by approximately 25 percent when the results of the Enlistment test are controlled for.

Moreover, the test score estimate seems to be only marginally affected by including the respective parental-background variable in the model, which indicates that the test score effect is very robust.

Finally (in column 6 for fathers and column 7 for mothers), an interaction variable between the parents' education/income and the test result is added to the earlier specification. In all the cases the interactions turn out to be statistically significant, and since the intergenerational associations also decrease substantially, by about 40 to 60 percent (when the interactions are added), the interactions of parental-background and cognitive ability seem to be important not only statistically but also of economically. This indicates that modeling intergenerational transmission as linear effects is incorrect and a strong simplification. The test score effects also decrease in this specification; in the case of the sons' earnings we actually find a negative test score effect. This is not uncommon when using interactions, though.

3.2 Ability heterogeneity in intergenerational mobility

To find out whether there is ability heterogeneity in intergenerational mobility, we analyze whether the intergenerational associations vary over the test score distribution. We do this by creating M dummy variables δ_m, where $m \in [1,...,9]$, one for each test group, and interacting them with the father's/mother's education or the father's income. This means that for each test score group we use a separate parental-background variable. The following expression models the relationship between the father's, S_f, and the son's, S_s education level:

$$S_s = \sum_{m=1}^{9} \delta_m \alpha_m + \sum_{m=1}^{9} \delta_m \beta_m S_f + \delta X + \varepsilon \qquad (1)$$

where β_m gives us the father-son intergenerational associations in education for each of the nine test score groups. We also allow for differences in the intercept between the test score groups (with use of m dummy variables, α_m); otherwise such differences will affect the results. The X represents the son's age and mother's and father's age at son's birth. A corresponding model is used to estimate the mother-son associations in education (using mother's education, S_m, instead of father's education, S_f) and the father-son associations in income (using son's income, I_s and father's income, I_f). The resulting estimates of β_m and α_m are reported in Table A1 in the Appendix.

Figure 1 (for education) and Figure 2 (for income) illustrate the intergenerational associations for each test score group. The intergenerational associations vary a great deal with the result of the Enlistment test.[22] In particular, the relationship between the test score and the intergenerational association in education (both for father's and mother's education) seems to be hump-shaped. Moreover, one reason for the relatively high

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[22] The variation in intergenerational associations could be caused by variance differences in the parental background variables between the test score groups. However, when estimating the intergenerational associations with standardized parental background variables (for each test score group), the variation increases further.

intergenerational association in education for the lowest test score group is, probably, that some otherwise relatively high-achieving individuals underachieve on the test with intent. This issue is further discussed in Nordin (2008).

These estimates should not be compared with standard intergenerational mobility estimates (which are higher) since we control here for test score differences. The relevant comparison is instead between test score groups. Figure 1 shows that the intergenerational association in education (for both fathers' and mothers' education) is highest when the son is a middle achiever on the Enlistment test. The intergenerational association in education for middle achievers is about twice as large as for low achievers, and is also larger than for high achievers (though here the difference is smaller).

Figure 2 illustrates the corresponding estimates for father-son income mobility (labelled Father's income, main sample). The intergenerational associations in income are inflated by signal-to-noise adjusting the estimates.[23] Also, the relationship between the test score and the intergenerational association in income seems somewhat hump-shaped. The figure shows a relatively high intergenerational association in income for particularly the second test score group, which seems strange. However, in the next section below (where the nonlinearities in the intergenerational associations are analyzed in depth) we see that there is a large nonlinearity in the lower part of the intergenerational association in income.

Thus, we have decided to re-estimate, using a restricted sample where all sons (no matter their test score) with a father belonging to the lowest income decentile are excluded. These estimates are also shown in Figure 2 (labeled Father's income, restricted sample).[24] The estimated intergenerational income associations for the three lowest test score groups decrease substantially when the individuals with a low-income father are excluded.[25]

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[23] For each test score group we construct the signal-to-noise ratio by first dividing the variance of the father's income (for a single year) by the variance of the mean father's income (for the three yearly). We then calculate the mean signal-to-noise ratio for the three income years. Figure A1 illustrates the change in the intergenerational associations in income when signal-to-noise adjusting the estimates.

[24] These estimates can also be found in Table A1 in the Appendix.

[25] When individuals with a father belonging to the lowest income decentile are excluded, large intercept changes occur (particularly for the lowest test score groups), which results in slope changes in the intergenerational associations in income for the lowest test score groups.

The estimates for the restricted sample (which we believe to capture the intergenerational association in income more accurately) show large differences in the intergenerational income mobility between the low and the middle test score groups. For the three lowest test score groups the correlation in income is around .05 whereas the correlation is around .25 for the test score groups four to nine. In addition, there is a tendency for a somewhat lower correlation in income for the highest test score groups than for the middle groups.

3.3 Nonlinear intergenerational correlations in education and income

As mentioned in the introduction, studies of heterogeneity and non-linearity in intergenerational mobility have often focused on variation across the distribution of parental income. For instance, Bratsberg et al. (2007) raise the issue of whether the intergenerational correlation in income is linear. They find a convex relationship between the father's and son's income in Denmark, Norway and Finland but a linear relationship in the US and the UK.

Since the distribution of parental outcomes among the test score groups differs largely (see Table 2), large nonlinearities in the intergenerational associations might imply that our results are biased. For example, if the intergenerational associations are concave, the associations will decrease with the test score level.

Our large data set also allows us to take a close look at such nonlinearities in our Swedish sample. To do this we have re-estimated the same baseline model as in section 3.1 (both with and without control for the test score), but now we use discrete sets of variables instead of continuous parental-background variables. Parental education is represented by six dummy variables and fathers´ income by ten dummy variables, each representing a decentile of the fathers' income distribution. The results are found in Table A2 (for fathers' and mothers' education) and in Table A3 (for fathers' income).

The estimation results are also illustrated in Figure A1 (for education) and in Figure A2 (for income), in both cases with and without control for the test score. Because specification (1) takes individual test score differences into account, in this case it is nonlinearities in the intergenerational associations when controlling for the test score that is problematic.

Whereas the intergenerational associations in education tend to be fairly linear, the father-son intergenerational correlation in income is, as in the other Nordic countries, somewhat convex. However, when adding the test score to the specification, the figures reveal that the nonlinearity in the intergenerational associations (especially for income) vanishes as the estimates for the upper part of the parental distributions decrease.

Figure A2 also shows that the nonlinearity in the left tail of the relationship entails a particularly low income for sons with a father belonging to the lowest income group. This is probably because the fathers in the lowest income decentile are often unemployed, i.e. employment effects are captured to a very large extent here. As discussed in section 3.2 above, this has implications for the intergenerational correlations in income for the lower test score groups and has led us to re-estimate using a restricted sample, with the result shown in Figure 2. But apart from the finding in the left tail of the father's income distribution, the relationship between intergenerational associations and the test score should not be affected by nonlinearities.

3.4 Intergenerational associations using a parental-background adjusted test score

As discussed earlier in the paper, the result in a cognitive ability test such as the Swedish Enlistment test is determined by both cognitive ability and non-cognitive abilities. This means that the test score achieved (at around age 18) can be expected to be influenced by and vary with the sons' parental- and family-background. We examine the influence of parental-background on the test score by regressing the test score on our parental-background variables. The results in Table A4 show that our three parental-background variables (father's education, mother's education, father's income) together explain about 14 percent of the variation in the sons' test score.[26]

Having done this we decided that it would be interesting to continue the analysis by looking at the intergenerational correlations in education and income when using a parental-background adjusted test score, $TS_{pb\text{-}adj}$. The residual from regressing the son's test score on the parents' education levels and the father's income is used to construct

[26] The first three columns (1-3) in Table A4 show the correlation between the test score and each of the parental-background variables. In column (4) we include the three parental background variables in the same model. The R^2-values indicate that the two parents' education levels are equally important for explaining the son's test score. The father's income is somewhat less important.

$TS_{pb\text{-}adj}$. The residuals range from relatively large negative values ("underachievers", i.e. sons performing markedly worse than expected on the test given their parental-background) over zero (sons performing as expected) to relatively large positive values ("overachievers", i.e. sons performing markedly better than expected given their parental-background). We then transform the residuals into a nine-point scale with the same mean and standard deviation as the original test score variable. It must be noted, however, that since the $TS_{pb\text{-}adj}$ variable measures whether the son performs higher/lower on the Enlistment test relative to what is expected for an individual with his parental-background, the research question changes. What we now investigate is whether the intergenerational associations differ among "underachievers", "middle achievers" and "overachievers" on the test. We do this by estimating the same model as in section 3.2 above, now using $TS_{pb\text{-}adj}$. instead of the actual test score.[27]

The resulting estimated intergenerational associations for the different groups of "achievers" are shown in Figure 3 (for education) and Figure 4 (for income). In all three cases the intergenerational associations are highest for the "middle achiever" groups and lower for both the "underachiever" and the "overachiever" groups. In other words, parental education and father's income have less of an influence on the educational attainment and the income of underperforming and overperforming sons than sons who perform as expected (from their parental-background) on the cognitive ability test. That is, underachievers and overachievers have higher intergenerational mobility in education as well as income.[28]

[Figure 3 about here]

[Figure 4 about here]

4. Conclusions

[27] In this case we do not exclude the individuals with a father belonging to the lowest income decentile, and we do not weight with the signal-to-noise ratio.

[28] When eliminating the parental background influence on the test score, there is a general increase in the intergenerational associations for the specific test score groups. This is a consequence of the construction of the $TS_{pb\text{-}adj}$ groups. Technically, since $TS_{pb\text{-}adj}$ = residual = $TS - PB$, for a certain $TS_{pb\text{-}adj}$ group; $Cov\ (TS,PB \backslash TS_{pb\text{-}adj}) > 0$. That is, for a $TS_{pb\text{-}adj}$ group the residual is (within a certain interval) constant. A positive relationship between the *TS*, and the *PB* exists because they simultaneously have to increase to keep the residual constant. Thus, within a $TS_{pb\text{-}adj}$ group a higher *PB* therefore implies a higher *TS*, and since the *TS* is positively related to both the education level and the income of the individual, the intergenerational association increases.

In this paper we investigate whether, and if so how, intergenerational associations in education and income in Sweden vary over the ability distribution of the children. We do this by using the results from a cognitive ability test, the Swedish Military Enlistment test, which virtually every male Swedish citizen takes at around age 18. The very large data set provides a unique opportunity to study different parts of both the cognitive ability and the parental-background distributions.

In several steps we introduce the results from the Enlistment test in our estimations of intergenerational associations. Our main aim in doing so is to find out whether there is ability heterogeneity in intergenerational transmission. We do this by estimating the intergenerational associations in education and income for nine different test score groups. The associations, (especially education) are clearly non-linear and hump-shaped, with the associations being highest for the middle ability groups and lower for both the higher ability and (particularly) lower ability groups.

Finding a hump-shaped relationship between intergenerational associations and children's test scores indicates that the result is not caused by an endogenous test score. That is, if more receptive children are pushed up or down the test score distribution due to parental influences, it is plausible to suspect that the intergenerational associations are higher in the tails.

Using a parental-background adjusted test score, we investigate whether the intergenerational associations in education and income differ among "underachievers", "middle achievers" and "overachievers" (relative to what would be expected from their parental-background) on the test. We find that underachievers and overachievers have higher intergenerational mobility than middle achievers in education as well as in income.

It is perhaps not so surprising to find that children with a relatively low or a relatively high cognitive ability (or a cognitive ability level that differs from what would be expected from their socioeconomic background) are less influenced by parental-background than children with an average cognitive ability (or a cognitive ability level that is in accordance with what would be expected from the child's socioeconomic background), but the differences between the test score groups are larger than expected.

In terms of increasing intergenerational mobility, the policy implication from this exploration is somewhat contra intuitive; to increase mobility one should primarily target the average child (or the middle achieving child). To some extent this is not in line with common policies, which often target the tails of the distribution. That is, policies often favor the already gifted (special school-classes), those with certain preferences (different types of private schools) or those with special needs, whereas those in the middle of the distribution are left in the hands of their parents.

The result may also imply that an intergenerational mobility-enhancing policy is not necessarily synonymous with an equality-enhancing policy. Hence, a policy that enhances the intergenerational mobility of the average child may decrease equality in general; i.e. when equalizing the opportunities of the average skilled sons, the sons may be less likely to follow in the footstep of their (in general) average skilled parent, thereby increasing inequality.

The overall conclusion is nevertheless that adding the cognitive ability dimension to studies of intergenerational mobility contributes new and important insights and should be pursued further in future research.

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Tables and figures

Table 1. Summary Statistics.

Variable	*Mean*	*St. dev.*
Years of schooling	12.36	2.08
Logarithmic annual income	12.39	.61
Age in 2003	33.40	2.87
Test Score	5.24	1.89
Father's level of education	11.29	2.40
Mother's level of education	11.34	2.26
Average (positive) logarithmic income 1970, 1975 and 1980, father	11.08	.37
Father's age at son's birth	26.48	5.20
Mother's age at son's birth	23.95	4.70
N	330,911	

Table 2. Mean parental-background variables for each test score group.

Test Score	*Father's log. income*	*Father's level of education*	*Mother's level of education*	*N*
1	10.93	10.04	10.25	8,157
2	10.95	10.20	10.37	19,880
3	10.99	10.40	10.57	32,095
4	11.02	10.66	10.78	47,605
5	11.06	11.06	11.13	80,482
6	11.11	11.56	11.56	57,234
7	11.16	12.06	12.00	43,570
8	11.21	12.52	12.45	26,823
9	11.26	13.17	13.02	15,065
Total	11.08	11.29	11.34	330,911

Table 3. Intergenerational associations in education and income.

Education	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Father's education	.301 (.001)***			.184 (.001)***		.074 (.004)***	
Mother's education		.289 (.002)***			.169 (.001)***		.065 (.004)***
Test score			.578 (.002)***	.513 (.002)***	.523 (.002)***	.303 (.007)***	.323 (.008)***
Father's education*Test Score						.019 (.001)***	
Mother's education*Test Score							.018 (.001)***
R2	.199	.181	.349	.386	.377	.388	.379
Income							
Father's income	.187 (.003)***			.142 (.003)***		.084 (.009)***	
Test score			.057 (.001)***	.053 (.001)***		-.060 (.016)***	
Father's income*Test Score						.010 (.001)***	
R2	.052		.071	.076		.077	

Notes: The estimates are the intergenerational elasticities. The results in the study are similar if we calculate the intergenerational correlations, i.e. if we multiply the elasticity coefficients by the ratio of the standard deviations of the parents' and the children's outcomes. In the upper part of the table the dependent variable is years of schooling, and in the lower part of the table the dependent variable is logarithmic annual income from work. The father's income is average logarithmic income. In all models son's age and mother's and father's age at son's birth are controlled for. Standard errors in parentheses. The number of observations is 330,911.

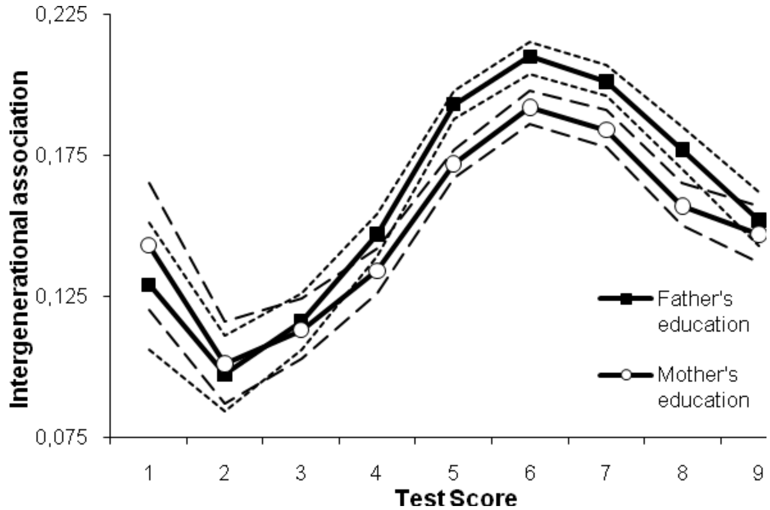

Figure 1. Illustrating the intergenerational associations in education (with 95% coeff. int.) for each test score group.

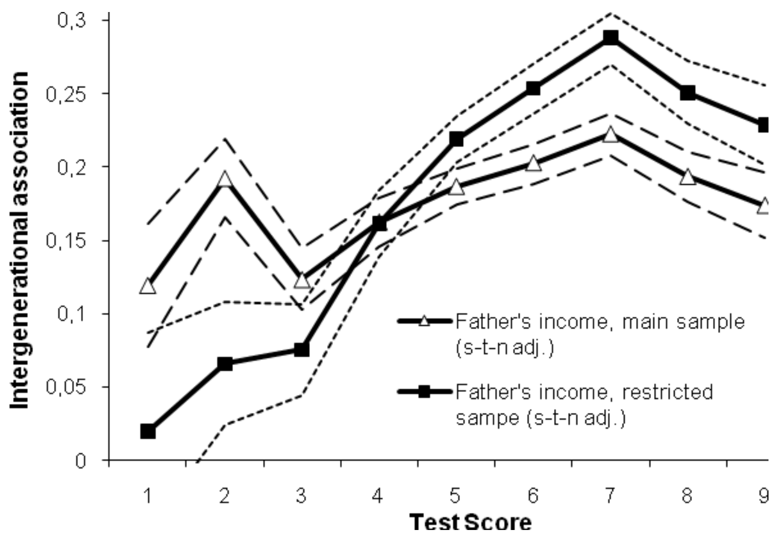

Figure 2. Illustrating the intergenerational associations in income (with 95% coeff. int.) for each test score group (with signal-to-noise adjusted estimates).

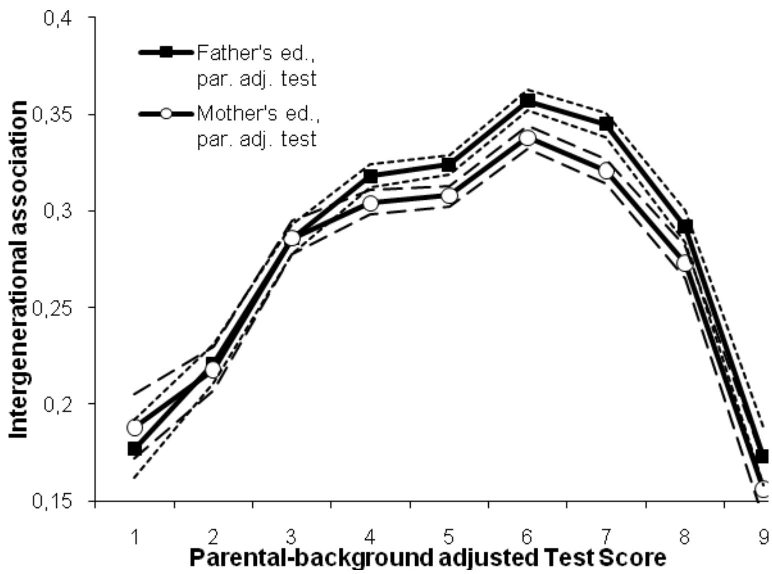

Figure 3. Illustrating the intergenerational associations in education (with 95% coeff. int.) for the parental-background adjusted test score groups.

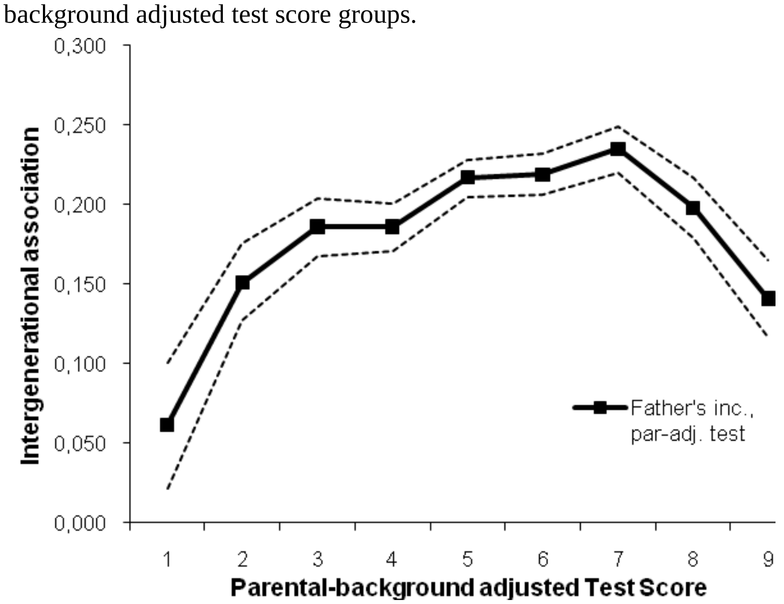

Figure 4. Illustrating the intergenerational associations in income (with 95% coeff. int.) for the parental-background adjusted test score groups.

Appendix

Table A1. The intergenerational associations in education and income for each test score group.

	Education		Income (father-son)	
Intergenerational association (β_m) for:	*Father-son*	*Mother-son*	*Main sample*	*Restricted sample*
Test score group 1	.129 (.012)***	.143 (.012)***	.082 (.021)***	.013 (.034)
Test score group 2	.097 (.007)***	.101 (.007)***	.129 (.013)***	.042 (.021)**
Test score group 3	.116 (.005)***	.113 (.005)***	.086 (.011)***	.048 (.016)***
Test score group 4	.147 (.004)***	.134 (.004)***	.115 (.008)***	.103 (.012)***
Test score group 5	.193 (.003)***	.172 (.003)***	.139 (.006)***	.140 (.008)***
Test score group 6	.210 (.003)***	.192 (.003)***	.156 (.007)***	.162 (.009)***
Test score group 7	.201 (.003)***	.184 (.003)***	.170 (.007)***	.184 (.009)***
Test score group 8	.177 (.004)***	.157 (.004)***	.156 (.009)***	.160 (.011)***
Test score group 9	.152 (.005)***	.147 (.005)***	.152 (.011)***	.146 (.014)***
Test score effect (α_m):				
Test score group 1	-.671 (.121)***	-1.048 (.124)***	.392 (.242)	1.167 (.385)***
Test score group 2	-.106 (.078)	-.369 (.083)***	-.029 (.161)	.949 (.250)***
Test score group 3	-.025 (.061)	-.219 (.065)***	.496 (.134)***	.923 (.193)***
Test score group 4	-.009 (.050)	-.105 (.054)*	.222 (.113)**	.361 (.157)**
Test score group 6	.461 (.044)***	.445 (.047)***	-.126 (.100)	-.191 (.130)
Test score group 7	1.157 (.047)***	1.146 (.050)***	-.224 (.105)**	-.373 (.134)***
Test score group 8	2.043 (.055)***	2.076 (.058)***	-.013 (.117)	-.055 (.150)
Test score group 9	2.941 (.070)***	2.796 (.074)***	.065 (.143)	.146 (.178)
N	330,911	330,911	330,911	297,819
R2	.394	.385	.077	.075

Notes: In the two first columns of the table the dependent variable is years of schooling, and in the two last columns of the table the dependent variable is logarithmic annual income from work. The father's income is average logarithmic income. In all models son's age and mother's and father's age at son's birth are controlled for. Standard errors in parentheses.

Table A2. The discrete intergenerational associations in education.

	(1)	(2)	(3)	(4)
Father compulsory education	ref	ref		
Father short upper-sec. eduation	.359 (.009)***	.195 (.007)***		
Father long upper-sec. eduation	.937 (.010)***	.495 (.009)***		
Father short College/University	1.239 (.012)***	.709 (.011)***		
Father long College/University	2.152 (.012)***	1.329 (.010)***		
Father Graduate	2.982 (.028)***	1.953 (.025)***		
Mother compulsory education			ref	ref
Mother short upper-sec. eduation			.403 (.008)***	.224 (.007)***
Mother long upper-sec. eduation			.989 (.014)***	.507 (.013)***
Mother short College/University			1.312 (.011)***	.744 (.010)***
Mother long College/University			2.042 (.012)***	1.201 (.011)***
Mother Graduate			3.008 (.059)***	1.942 (.051)***
Test score		.511 (.002)***		.522 (.002)***
R2	.203	.388	.184	.378

Notes: The dependent variable is years of schooling. In all models son's age and mother's and father's age at son's birth are controlled for. Standard errors in parentheses. The number of observations is 330,911.

Table A3. The discrete intergenerational associations in income

Father's income group (decentile):	*(1)*	*(2)*
1	ref	ref
2	.054 (.005)***	.057 (.005)***
3	.068 (.005)***	.068 (.005)***
4	.083 (.005)***	.080 (.005)***
5	.104 (.005)***	.099 (.005)***
6	.124 (.005)***	.115 (.005)***
7	.128 (.005)***	.113 (.005)***
8	.160 (.005)***	.134 (.005)***
9	.189 (.005)***	.148 (.005)***
10	.266 (.005)***	.203 (.005)***
Test score		.053 (.001)***
R2	.053	.072

Notes: The dependent variable is logarithmic annual income from work. In all models son's age and mother's and father's age at son's birth are controlled for. Standard errors in parentheses. The number of observations is 330,911.

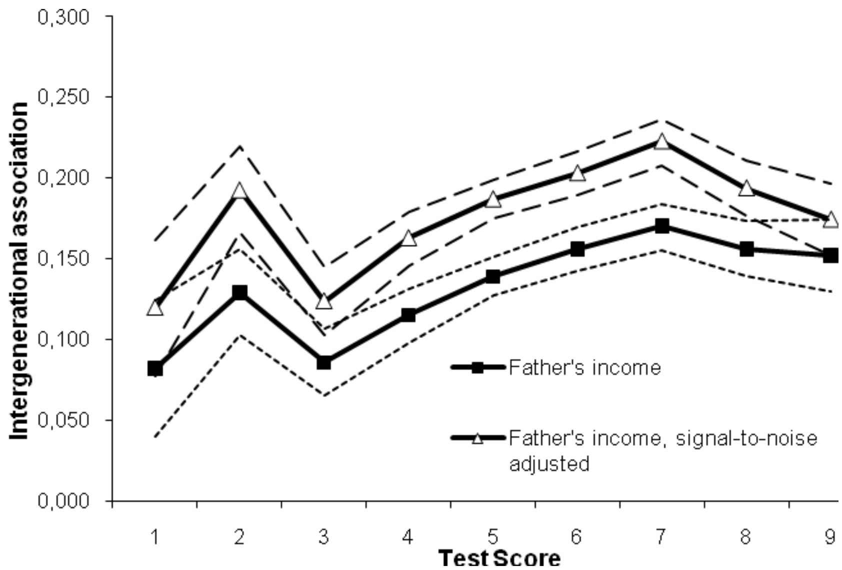

Figure A1. Illustrating the intergenerational associations in income for each test score group with, and without, signal-to-noise adjusted estimates (with 95% coeff. int.).

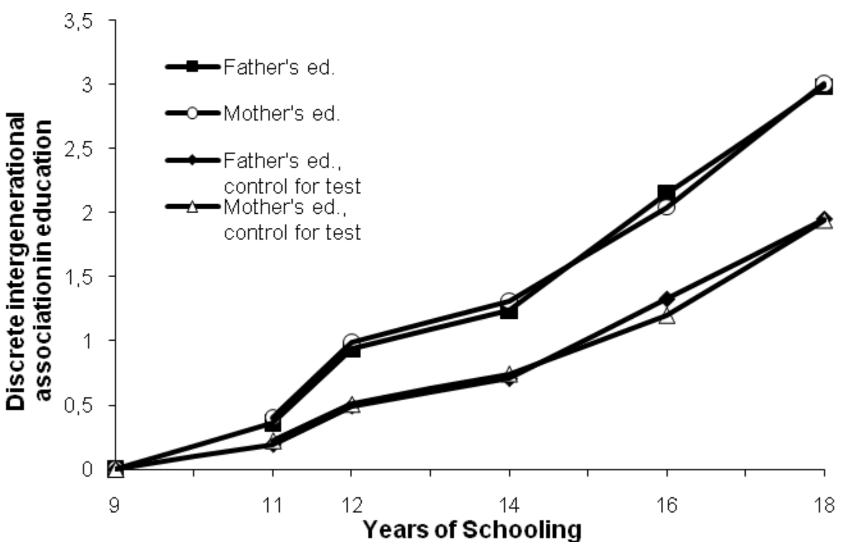

Figure A2. The discrete intergenerational associations in education (the 95% coeff. int. is too narrow to plot).

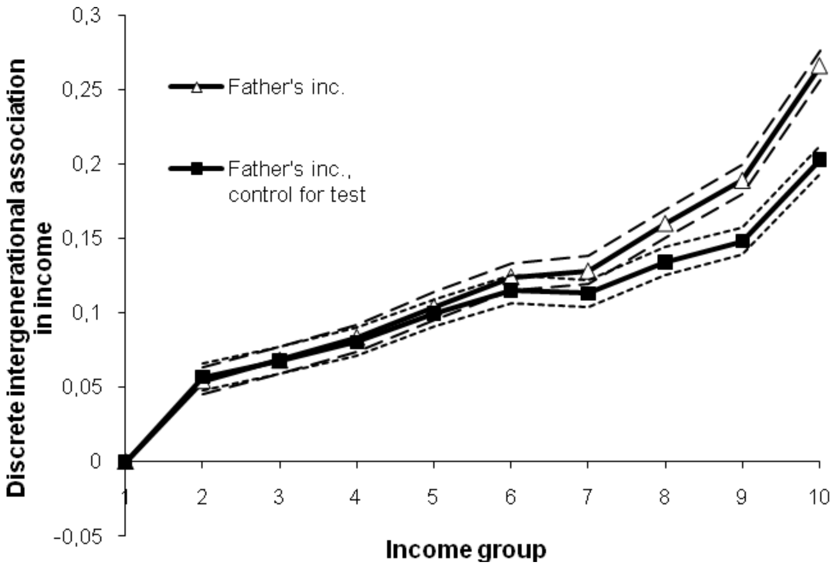

Figure A3. The discrete intergenerational associations in income (with 95% coeff. int.).

Table A4. Exploring the variation in the test score

	(1)	*(2)*	*(3)*	*(4)*
Father's education	.255 (.001)***			.150 (.002)***
Mother's education		.253 (.001)***		.155 (.002)***
Father's income			1.159(.009)***	.579 (.009)***
R2	.105	.092	.051	.144

Notes: The dependent variable is the test score. The father's income is average logarithmic income. Standard errors in parentheses. The number of observations is 330,911.