

ADJUSTING SCHOOL TEST SCORE PERFORMANCE FOR FAMILY BACKGROUND AN EXPLANATORY NOTE

Background

Testing and focus on measurable cognitive outcomes has been a slowly growing feature of the compulsory schooling years in Denmark. This follows mediocre performance in influential comparative studies such as the OECD Programme for International Student Assessment (PISA). Subsequently, school-wise mean performance in standard national tests taken at the end of compulsory schooling have been published. Raw rankings of mean scores have been used to construct school league tables which, when published annually, receive much popular attention.

Motivation

Schools can only work with what homes send them. Pupils arrive at school with different endowments, teachers educate with a view to the level and ambition appropriate to the class, pupils and parents adjust their behaviour to make the most of the educational opportunities as they see them. In the language of educational production, there are a large number of inputs and behavioural responses leading to a variety of outputs. It is the aim of this study to describe how the distribution of test scores can be explained with administrative register information about the pupils. Specifically, we focus on one outcome (test scores) and a small number of inputs (17 observed pupil characteristics together with school identity). The objective is to describe school-level differences in test score outcomes that are adjusted for selected observed family background characteristics.

Contribution

Previous work (AE 2005 and CEPOS 2006) used 2 or 3 years of scores and respectively tests and teacher assessments or grade point averages as outcome variables. A modest set of family background characteristics are controlled for in a first stage Ordinary Least Squares (OLS) regression model, and respectively municipality and school effects are calculated from means of these residuals. Concurrent to our study, Rangvid (in press) has extended these earlier works by using 5 years of test score data and controls for a more complete set of family background characteristics in a joint estimation of school effects. Our study is closest in spirit to Rangvid in terms of the extensions we have made and the approach taken. Our focus is more narrowly making inference about adjusted school performance but at the same time focusing on the statistical precision of these individual estimates. Our two studies should be regarded as complements rather than substitutes, as their contributions are different.

Identification

Even within the narrow scope of trying to explain test scores with a handful of observed child characteristics, the inferences that we claim to make are limited in important ways. Everything that we cannot observe in these 17 characteristics, but that varies between schools, will be attributed to a so called "school effect". However, we only adjust school performance for these selected characteristics. It is popular in the educational statistics literature to estimate school effects in a "value added" framework. In that framework, ideally pupils are tested before a certain intervention and then randomised into treatment and control groups for exposure to the intervention and finally re-tested. In practice, randomisation is often not feasible and observational data is used on test score differences for pupils who allocate themselves into different groups. Though in principle observational is a much weaker design than experimental because of self selection issues, both value added approaches have the benefit of controlling for initial test performance. In the current context, for the sake of evaluation, ideally pupils would be tested, randomised to schools, then re-tested. Neither do we have baseline testing or randomization. Initial performance cannot be controlled for and parents allocate their children to schools according to where they live and what they think is in the child's best interest. In

this case, proper evaluation of the effect of schools on pupil performance is difficult, and beyond the ambit of the current study. We estimate "school effects" only in a loose sense, with no causal interpretation, but use this common terminology hereafter to refer to mean school test scores adjusted for family characteristics.

Data description

During the analysis period (2002-6) we observe individual 9th grade test scores in Danish (neatness, oral, written, spelling) and Mathematics (oral, written) on the old 13-point scale. We retain all pupils with a valid score, valid institution identifier, the institution must be "grundskole", valid personal demographic information (pupils with missing mother and/or father information are kept) and each pupil must only take tests at a single institution in a given year. This sample forms the basis of all subsequent analyses. Table 1 presents mean test scores according to different realisations of 17 observed characteristics. Selected characteristics throughout are dummy variables for gender, calendar year of taking test, mother/father registered, household disposable (after taxes and benefits) income adjusted for household size (deciles of the distribution in the test year), pupil age in months at test time, number of brothers and sisters living in the household at test time, family residential structure (living with lone father, etc), mother/father age at child's birth, place of birth, mother/father education and labour market status at test time. The table contains simple conditional means on the raw data and conforms entirely with prior beliefs about correlates of the test score distribution. Note that pupils are retained with missing information for mother and/or father, so parental education, labour market status, place of birth and age at child's birth are all conditional on observing the parent in question.

Specification

There is a tradeoff to be made between statistical elegance and computational transparency. From an efficiency perspective, as much of the available variance in the raw data should be explained as possible. Taking student means or grade point averages throws away within-pupil variation between-tests, but the variance that remains is easier to explain with observed characteristics. Here we follow both approaches. Furthermore, strictly speaking test scores are not continuous outcomes - 1, 2, 4 & 12 are unobtainable. Also they are ordinal but not necessarily cardinal, for example 6 is obviously better than 3, but is it twice as good? Standard statistical methods are available to deal with discontinuous ordinal dependent variables, but they rely on additional assumptions and produce estimates which do not have a direct interpretation. Furthermore, generalization to the present context of estimating school effects is non-standard and inflexible. In view of this, we choose the econometrician's workhorse OLS estimator. Although this assumes for the sake of computation that 6 is twice as good as 3 and grade 12 is hypothetically obtainable, grade point averages are common currency in popular discussion of test performance, so they are assumptions commonly made. OLS generalises easily to produce consistent estimates of school effects.

In all of the regressions mathematics is weighted equally with Danish so that both subjects count equally in overall performance. Since only two mathematics scores are reported throughout, but four Danish scores, each mathematics score gets a double weight so that overall for a pupil taking all six tests, the importance of mathematics and Danish scores would balance. Estimated population OLS coefficients are presented in table 2. There are three groups of columns representing different estimations. The first two use test observations and the last uses weighted average of scores per pupil. The first and the last group of columns present coefficients estimated without taking into account school identity. It is then the school mean residual (unexplained part) that forms an estimate of the school effect. The middle group of columns presents population coefficients which are estimated jointly with account being taken of school identity. Another difference between the middle and the outer groups of columns is that only schools with 500 or more test scores are included in estimation of the

middle. This is because the ultimate objective is to produce school adjustments and estimated adjustment precision falls for smaller schools. This cut-off is arbitrary. Estimating the first and the last groups of columns on this restricted sample did not change the population parameter estimates significantly and so are not reported.

Important inferential issues arise regarding estimate precision. In the two step estimation, population effects are estimated in a first stage and themselves have a variance which needs to be accounted for in the second stage. In the joint estimation, observations are clustered at the school-level and not taking into account this within-group correlation could overstate precision. These issues are addressed by running 1000 bootstrap replications of the weighted test score observations or student means as appropriate. It is the distribution of these estimates from which confidence intervals for school effects (and for population parameters in the jointly estimated model) are calculated.

Results

Estimated OLS coefficients are always to be interpreted "all else equal" i.e. the marginal effect of the variable in question holding constant all other variables that are being controlled for in the model. This extensive conditioning explains the big differences between simple conditional means of table 1 and model estimates of table 2. The only difference in conditioning to be aware of within table 2 is that the middle group of columns is jointly estimated with school effects, so these population parameters are conditioned on those too. Estimates are entirely conventional according to prior expectations and are precisely estimated. The estimated school effects themselves and confidence intervals are only calculated for schools with more than 500 test score observations. These are presented elsewhere.

Discussion

Selected family background characteristics explain about 20% of population test score variation. With 5 years of data and schools of moderate size, adjusted school effects are fairly precisely estimated. Not all pupils take the test and not all schools report, though the proportions are growing. Issues of selection into the test are ignored. Pupils change school from time-to-time, yet school affiliation at test time is all that is accounted for. In other contexts educational statisticians exploit school changers in order to distinguish pupil- from school-effects. However, econometricians question using such choice-based changes for identification. Nevertheless, accounting for school affiliation history is in principle possible, and would better attribute effects of pupil's school careers, especially given the number of switches between 8th and 9th grade.

What is the school effect comprised of? Everything that varies at the school level but is not captured by our 17 explanatory variables. It remains for future work to analyse the determinants of estimated adjusted school test performance. It is simple enough to run auxiliary regressions explaining these between-school differences, but it is beyond the scope of the current report.

table 1 conditional means by test type

description	label	ref	Danish - oral		Danish - neatness		Danish - spelling		Danish - written		Maths - oral		Maths - written		All 6 (unweighted)	
			mean	se(mean)	mean	se(mean)	mean	se(mean)	mean	se(mean)	mean	se(mean)	mean	se(mean)	mean	se(mean)
gender	female	*	8,7347	0,0047	8,1305	0,0044	8,3314	0,0039	8,0743	0,0025	8,1786	0,0046	7,7285	0,0046	8,1971	0,0017
	male		8,2026	0,0048	7,6392	0,0046	7,6812	0,0040	7,6870	0,0026	8,2633	0,0048	7,9626	0,0045	7,9056	0,0018
observation year	2002		8,4858	0,0078	8,0283	0,0080	7,9957	0,0069	7,9369	0,0047	8,2829	0,0076	7,7911	0,0079	8,0868	0,0030
	2003		8,5014	0,0078	7,8064	0,0075	8,0122	0,0065	7,8936	0,0042	8,2722	0,0074	7,9321	0,0071	8,0693	0,0028
	2004	*	8,4493	0,0076	7,9928	0,0067	8,0189	0,0064	7,8789	0,0040	8,2447	0,0073	7,8599	0,0073	8,0740	0,0027
	2005		8,4559	0,0074	7,8822	0,0072	8,0028	0,0063	7,8594	0,0040	8,2378	0,0071	7,8259	0,0070	8,0438	0,0027
	2006		8,4597	0,0074	7,7399	0,0066	8,0068	0,0061	7,8465	0,0038	8,0846	0,0076	7,8227	0,0069	7,9931	0,0027
	father identified		*	8,4833	0,0035	7,9051	0,0033	8,0242	0,0029	7,8892	0,0019	8,2394	0,0034	7,8687	0,0033	8,0681
father not observed			8,2192	0,0154	7,5301	0,0147	7,6977	0,0130	7,7370	0,0082	7,8820	0,0150	7,4264	0,0149	7,7482	0,0057
mother identified	mother observed	*	8,4748	0,0034	7,8928	0,0032	8,0135	0,0029	7,8840	0,0019	8,2272	0,0033	7,8535	0,0032	8,0574	0,0013
	mother not observed		8,0931	0,0299	7,3652	0,0294	7,5559	0,0270	7,6837	0,0165	7,7727	0,0292	7,2847	0,0298	7,6251	0,0113
equivalent disposable income decile	decile 1 (lowest)		7,9516	0,0113	7,2219	0,0108	7,4110	0,0095	7,6168	0,0063	7,6136	0,0113	7,0868	0,0114	7,4829	0,0043
	decile 2		8,0186	0,0110	7,4277	0,0103	7,5844	0,0092	7,6902	0,0061	7,6911	0,0107	7,2407	0,0106	7,6086	0,0041
	decile 3		8,1705	0,0107	7,6228	0,0101	7,7498	0,0090	7,7616	0,0060	7,8786	0,0105	7,4808	0,0102	7,7773	0,0039
	decile 4		8,3025	0,0107	7,7691	0,0099	7,8875	0,0088	7,8257	0,0059	8,0424	0,0103	7,6731	0,0099	7,9166	0,0039
	decile 5	*	8,4037	0,0105	7,8446	0,0099	7,9755	0,0088	7,8669	0,0058	8,1549	0,0102	7,7942	0,0098	8,0066	0,0038
	decile 6		8,4791	0,0104	7,9153	0,0098	8,0486	0,0087	7,9122	0,0057	8,2584	0,0101	7,8977	0,0096	8,0852	0,0038
	decile 7		8,5907	0,0104	8,0282	0,0097	8,1398	0,0087	7,9455	0,0057	8,3666	0,0099	8,0310	0,0094	8,1836	0,0038
	decile 8		8,6993	0,0103	8,1133	0,0096	8,2326	0,0086	7,9883	0,0055	8,4760	0,0098	8,1418	0,0093	8,2752	0,0037
	decile 9		8,8694	0,0102	8,2674	0,0096	8,3692	0,0086	8,0426	0,0055	8,6494	0,0097	8,3300	0,0090	8,4214	0,0037
	decile 10 (highest)		9,0916	0,0101	8,5300	0,0092	8,5654	0,0084	8,1143	0,0053	8,9216	0,0095	8,6211	0,0087	8,6408	0,0036
age at test time	14 years 9 months, or less		7,6442	0,0134	6,7029	0,0126	7,0649	0,0110	7,4846	0,0076	7,4023	0,0135	6,8782	0,0137	7,1947	0,0051
	14 years 10 months		8,1278	0,0244	7,3729	0,0229	7,6195	0,0204	7,6982	0,0133	7,8804	0,0240	7,4743	0,0239	7,6949	0,0090
	14 years 11 months		8,3082	0,0181	7,6364	0,0171	7,8228	0,0154	7,7863	0,0098	8,0584	0,0183	7,6809	0,0178	7,8816	0,0068
	15 years 0 months		8,4459	0,0136	7,8366	0,0128	7,9827	0,0115	7,8585	0,0073	8,2291	0,0135	7,8607	0,0130	8,0354	0,0050
	15 years 1 month		8,5238	0,0131	7,9076	0,0123	8,0575	0,0111	7,8963	0,0072	8,2670	0,0128	7,8993	0,0125	8,0918	0,0048
	15 years 2 months		8,5485	0,0119	7,9379	0,0111	8,0904	0,0100	7,9176	0,0064	8,2981	0,0116	7,9348	0,0112	8,1211	0,0044
15 years 3 months		8,5481	0,0119	7,9544	0,0110	8,0781	0,0099	7,9146	0,0064	8,3036	0,0115	7,9293	0,0110	8,1213	0,0043	

15 years 4 months	*	8,5368	0,0118	7,9661	0,0109	8,0736	0,0099	7,9051	0,0064	8,2793	0,0114	7,9180	0,0110	8,1129	0,0043
15 years 5 months		8,5185	0,0118	7,9617	0,0111	8,0752	0,0099	7,9080	0,0064	8,2892	0,0115	7,9188	0,0111	8,1118	0,0043
15 years 6 months		8,5319	0,0117	7,9597	0,0109	8,0697	0,0097	7,9169	0,0063	8,2886	0,0112	7,9195	0,0108	8,1143	0,0042
15 years 7 months		8,5038	0,0120	7,9662	0,0110	8,0523	0,0099	7,9111	0,0065	8,2744	0,0114	7,9126	0,0110	8,1032	0,0043
15 years 8 months		8,5363	0,0122	8,0264	0,0113	8,1141	0,0103	7,9232	0,0067	8,2744	0,0119	7,9372	0,0114	8,1352	0,0045
15 years 9 months		8,5501	0,0130	8,0481	0,0120	8,1096	0,0108	7,9259	0,0070	8,2839	0,0127	7,9345	0,0121	8,1420	0,0047
15 years 10 months		8,5523	0,0146	8,1040	0,0134	8,1421	0,0120	7,9474	0,0080	8,3108	0,0142	7,9620	0,0136	8,1697	0,0053
15 years 11 months		8,5901	0,0172	8,1520	0,0157	8,1788	0,0141	7,9665	0,0092	8,3101	0,0165	7,9391	0,0156	8,1894	0,0062
16 years 0 months, or more		8,8965	0,0192	8,4736	0,0175	8,3981	0,0161	8,0377	0,0104	8,5638	0,0185	8,1875	0,0177	8,4262	0,0070
number of brothers in the household															
0		8,4822	0,0043	7,8976	0,0040	8,0215	0,0036	7,8863	0,0023	8,2152	0,0042	7,8371	0,0040	8,0565	0,0016
1	*	8,4919	0,0062	7,9212	0,0059	8,0370	0,0052	7,8962	0,0033	8,2671	0,0061	7,9085	0,0059	8,0868	0,0023
2		8,3190	0,0140	7,7088	0,0135	7,8311	0,0120	7,8029	0,0076	8,1355	0,0138	7,7356	0,0138	7,9217	0,0052
3 or more		7,9877	0,0331	7,2310	0,0330	7,3836	0,0287	7,6303	0,0184	7,7633	0,0337	7,2429	0,0349	7,5385	0,0128
number of sisters in the household															
0		8,4687	0,0042	7,8860	0,0040	8,0091	0,0036	7,8806	0,0023	8,2019	0,0041	7,8249	0,0040	8,0451	0,0016
1	*	8,5050	0,0063	7,9290	0,0059	8,0438	0,0053	7,8958	0,0034	8,2927	0,0062	7,9330	0,0060	8,0997	0,0023
2		8,3842	0,0149	7,7801	0,0142	7,9054	0,0127	7,8536	0,0080	8,1593	0,0146	7,7613	0,0145	7,9736	0,0055
3 or more		7,9897	0,0338	7,2146	0,0336	7,4241	0,0291	7,6655	0,0186	7,7061	0,0339	7,1378	0,0342	7,5220	0,0129
test-taker lives with															
mother + father	*	8,5552	0,0041	7,9645	0,0039	8,0844	0,0035	7,9311	0,0022	8,3524	0,0040	7,9921	0,0039	8,1465	0,0015
mother re-married		8,2861	0,0104	7,7353	0,0097	7,8576	0,0086	7,8065	0,0057	7,9496	0,0101	7,5875	0,0098	7,8704	0,0038
lone mother		8,3653	0,0086	7,7990	0,0080	7,9188	0,0071	7,8056	0,0046	8,0000	0,0084	7,5862	0,0082	7,9125	0,0032
father re-married		8,2114	0,0255	7,6353	0,0239	7,7569	0,0212	7,7291	0,0139	7,9476	0,0244	7,5287	0,0237	7,8012	0,0093
lone father		8,2205	0,0191	7,6756	0,0175	7,7899	0,0161	7,7259	0,0106	7,9486	0,0188	7,5656	0,0181	7,8208	0,0070
other arrangements		7,8661	0,0269	7,0898	0,0261	7,3176	0,0232	7,5038	0,0162	7,4211	0,0270	6,8063	0,0275	7,3341	0,0103
mother place of birth															
Denmark	*	8,5402	0,0036	7,9756	0,0034	8,0927	0,0030	7,9108	0,0020	8,2915	0,0035	7,9477	0,0033	8,1263	0,0013
the west		8,5862	0,0221	8,1123	0,0202	8,1069	0,0184	7,8883	0,0117	8,3673	0,0214	8,0000	0,0206	8,1765	0,0080
rest-of-world		7,7673	0,0120	6,9822	0,0110	7,1754	0,0096	7,6076	0,0065	7,5153	0,0122	6,8429	0,0120	7,3141	0,0045
father place of birth															
Denmark	*	8,5420	0,0037	7,9810	0,0034	8,0966	0,0031	7,9144	0,0020	8,3027	0,0035	7,9626	0,0034	8,1331	0,0013
the west		8,6594	0,0234	8,1541	0,0209	8,1819	0,0190	7,9115	0,0121	8,3465	0,0222	7,9733	0,0212	8,2043	0,0083
rest-of-world		7,8188	0,0125	7,0492	0,0113	7,2290	0,0100	7,6208	0,0067	7,5384	0,0125	6,8581	0,0122	7,3516	0,0046
mother age when child born															
teenage		7,6968	0,0219	7,0025	0,0209	7,2100	0,0182	7,5451	0,0127	7,3615	0,0216	6,8037	0,0217	7,2696	0,0083
20-24		8,1009	0,0073	7,5199	0,0068	7,6672	0,0060	7,7450	0,0041	7,8674	0,0071	7,4420	0,0070	7,7234	0,0027
25-29	*	8,5014	0,0053	7,9174	0,0050	8,0414	0,0045	7,9070	0,0029	8,2807	0,0052	7,9212	0,0050	8,0947	0,0020

30-34	8,6970	0,0067	8,1185	0,0062	8,2197	0,0056	7,9610	0,0036	8,4335	0,0064	8,0868	0,0062	8,2526	0,0024
35-39	8,7718	0,0119	8,2182	0,0111	8,2997	0,0101	7,9688	0,0063	8,4512	0,0115	8,1037	0,0110	8,3021	0,0043
40 plus	8,7339	0,0286	8,1690	0,0279	8,2333	0,0244	7,9446	0,0155	8,3272	0,0281	8,0197	0,0271	8,2381	0,0106
father age when child born														
teenage	7,6679	0,0467	7,0782	0,0449	7,2815	0,0390	7,5817	0,0266	7,2964	0,0464	6,7477	0,0483	7,2761	0,0178
20-24	8,0195	0,0106	7,4334	0,0099	7,5947	0,0087	7,7079	0,0059	7,7489	0,0104	7,3056	0,0103	7,6348	0,0039
25-29	*	8,4060	7,8109	0,0057	7,9464	0,0051	7,8662	0,0034	8,1933	0,0059	7,8173	0,0057	8,0064	0,0022
30-34	8,5924	0,0060	8,0189	0,0057	8,1310	0,0051	7,9393	0,0033	8,3661	0,0058	8,0167	0,0056	8,1773	0,0022
35-39	8,6766	0,0087	8,1176	0,0083	8,2047	0,0074	7,9466	0,0047	8,3912	0,0084	8,0440	0,0081	8,2301	0,0032
40 plus	8,6186	0,0128	8,0677	0,0120	8,1516	0,0109	7,9177	0,0069	8,2936	0,0124	7,9212	0,0120	8,1617	0,0047
mother labour market status														
self-employed	8,6270	0,0187	8,0651	0,0173	8,1143	0,0156	7,9314	0,0100	8,3847	0,0179	8,0556	0,0169	8,1963	0,0068
wage earner	8,5661	0,0038	7,9987	0,0035	8,1123	0,0032	7,9267	0,0020	8,3333	0,0036	7,9833	0,0035	8,1533	0,0014
unemployed	8,0419	0,0195	7,5014	0,0181	7,6326	0,0162	7,7176	0,0106	7,7437	0,0191	7,3340	0,0187	7,6619	0,0071
education	8,7084	0,0613	8,0919	0,0578	8,1992	0,0528	7,9159	0,0336	8,3219	0,0558	8,0837	0,0549	8,2198	0,0221
activation program	7,9830	0,0224	7,2842	0,0212	7,4764	0,0190	7,6575	0,0125	7,6493	0,0222	7,1331	0,0223	7,5302	0,0084
welfare	7,6248	0,0215	6,8102	0,0198	7,0750	0,0174	7,4741	0,0123	7,2126	0,0220	6,5409	0,0217	7,1230	0,0081
other out-of-labour-force	8,0469	0,0126	7,4091	0,0119	7,5612	0,0106	7,6886	0,0069	7,7301	0,0123	7,2537	0,0123	7,6145	0,0047
father labour market status														
self-employed	8,5168	0,0108	7,9102	0,0103	8,0376	0,0092	7,9025	0,0059	8,3337	0,0104	7,9597	0,0101	8,1099	0,0040
wage earner	8,5521	0,0039	7,9908	0,0037	8,0978	0,0033	7,9216	0,0021	8,3146	0,0038	7,9679	0,0036	8,1407	0,0014
unemployed	8,1021	0,0212	7,5076	0,0200	7,6649	0,0179	7,7331	0,0115	7,7896	0,0209	7,3311	0,0206	7,6879	0,0078
education	8,5161	0,1593	8,0472	0,1440	8,1417	0,1395	7,8189	0,0684	8,0556	0,1595	7,9291	0,1300	8,0831	0,0562
activation program	7,9705	0,0364	7,2035	0,0346	7,4735	0,0318	7,6420	0,0198	7,6211	0,0354	7,1188	0,0357	7,5035	0,0136
welfare	7,7060	0,0277	6,9666	0,0256	7,2077	0,0227	7,5346	0,0158	7,3370	0,0283	6,6930	0,0274	7,2407	0,0104
other out-of-labour-force	8,0435	0,0139	7,3926	0,0130	7,5711	0,0117	7,6770	0,0076	7,6937	0,0137	7,1785	0,0137	7,5925	0,0052
mother education														
missing education information	7,8027	0,0185	7,0478	0,0181	7,2427	0,0159	7,5848	0,0103	7,5433	0,0183	6,9488	0,0186	7,3604	0,0070
grundskole	7,9541	0,0066	7,3858	0,0063	7,5373	0,0055	7,6904	0,0038	7,6845	0,0066	7,2290	0,0065	7,5801	0,0025
erhvervsfaglig	8,3439	0,0054	7,7811	0,0051	7,9136	0,0045	7,8648	0,0030	8,1260	0,0053	7,7696	0,0051	7,9663	0,0020
gymnasium or KVV	* 8,7990	0,0113	8,2986	0,0104	8,3435	0,0093	8,0180	0,0061	8,6021	0,0107	8,3089	0,0099	8,3949	0,0040
short tertiary	9,0108	0,0069	8,3713	0,0065	8,4912	0,0059	8,0574	0,0037	8,7101	0,0066	8,3795	0,0062	8,5034	0,0025
long tertiary	9,4553	0,0144	8,8872	0,0132	8,8621	0,0123	8,1538	0,0077	9,2040	0,0138	8,9470	0,0123	8,9181	0,0053
father education														
missing education information	8,1079	0,0130	7,4225	0,0123	7,5919	0,0109	7,7044	0,0070	7,7808	0,0127	7,2974	0,0127	7,6502	0,0048
grundskole	8,0269	0,0070	7,4488	0,0066	7,6046	0,0059	7,7116	0,0040	7,7370	0,0069	7,2911	0,0069	7,6365	0,0026
erhvervsfaglig	8,3587	0,0051	7,7794	0,0048	7,9200	0,0043	7,8691	0,0029	8,1374	0,0050	7,7744	0,0047	7,9731	0,0019
gymnasium or KVV	* 8,8010	0,0112	8,2363	0,0103	8,3151	0,0093	7,9962	0,0060	8,5427	0,0106	8,2277	0,0100	8,3531	0,0040

short tertiary	9,0302	0,0096	8,4422	0,0090	8,5291	0,0082	8,0705	0,0052	8,7826	0,0092	8,4631	0,0085	8,5529	0,0035
long tertiary	9,3275	0,0109	8,7855	0,0100	8,7803	0,0092	8,1488	0,0057	9,1086	0,0104	8,8256	0,0095	8,8294	0,0040
all														

table 2

description	headline estimates			test observations			test observations			pupil observations		
	definition	ref	coefficient	std. error	95% confidence	coefficient	std. error	95% confidence	coefficient	std. error	95% confidence	
which test												
	Danish - oral	*										
	male - Danish - neatness		-0,5604	0,0049	-0,5700 -0,5508	-0,5449	0,0065	-0,5559 -0,5347	-1,2788	0,2998	-1,8663 -0,6913	
	male - Danish - spelling		-0,5192	0,0044	-0,5279 -0,5105	-0,5122	0,0061	-0,5229 -0,5034	-0,2747	0,5508	-1,3542 0,8048	
	male - Danish - written		-0,5134	0,0047	-0,5226 -0,5042	-0,5057	0,0050	-0,5143 -0,4985	-0,4282	0,4912	-1,3909 0,5346	
	male - Maths - oral		0,0599	0,0050	0,0501 0,0696	0,0620	0,0054	0,0537 0,0710	1,2357	0,2597	0,7267 1,7446	
	male - Maths - written		-0,2373	0,0048	-0,2467 -0,2278	-0,2217	0,0055	-0,2305 -0,2123	-1,4022	0,2140	-1,8217 -0,9827	
	female - Danish - neatness		-0,6024	0,0047	-0,6117 -0,5931	-0,5919	0,0066	-0,6042 -0,5821	-1,3800	0,2968	-1,9617 -0,7982	
	female - Danish - spelling		-0,4020	0,0043	-0,4106 -0,3935	-0,3980	0,0054	-0,4086 -0,3908	0,2748	0,5459	-0,7951 1,3447	
	female - Danish - written		-0,6591	0,0047	-0,6683 -0,6499	-0,6576	0,0052	-0,6660 -0,6492	-0,6782	0,5557	-1,7674 0,4110	
	female - Maths - oral		-0,5630	0,0048	-0,5724 -0,5536	-0,5638	0,0058	-0,5735 -0,5543	1,6705	0,2122	1,2547 2,0864	
	female - Maths - written		-1,0094	0,0047	-1,0187 -1,0002	-0,9998	0,0055	-1,0095 -0,9915	-0,7877	0,1801	-1,1406 -0,4348	
gender	female	*										
	male		-0,5355	0,0064	-0,5480 -0,5230	-0,5390	0,0066	-0,5498 -0,5295	0,1024	0,2642	-0,4154 0,6202	
observation year	2002		0,0257	0,0067	0,0125 0,0389	0,0345	0,0032	0,0293 0,0400	0,0278	0,0068	0,0146 0,0411	
	2003		0,0245	0,0065	0,0117 0,0372	0,0297	0,0034	0,0229 0,0350	0,0218	0,0065	0,0090 0,0347	
	2004	*										
	2005		-0,0271	0,0064	-0,0396 -0,0147	-0,0269	0,0032	-0,0321 -0,0222	-0,0257	0,0064	-0,0383 -0,0132	
	2006		-0,0896	0,0064	-0,1021 -0,0770	-0,0908	0,0030	-0,0962 -0,0860	-0,0863	0,0064	-0,0989 -0,0737	
father identified	father observed	*										
	father not observed		0,1145	0,0195	0,0763 0,1528	0,1157	0,0101	0,0948 0,1305	0,1116	0,0195	0,0733 0,1499	
mother identified	mother observed	*										
	mother not observed		0,0791	0,0272	0,0257 0,1324	0,0511	0,0142	0,0275 0,0789	0,0733	0,0272	0,0200 0,1266	
equivalent disposable income decile	decile 1 (lowest)		-0,1921	0,0115	-0,2146 -0,1697	-0,1880	0,0056	-0,1968 -0,1792	-0,1986	0,0115	-0,2212 -0,1761	
	decile 2		-0,1625	0,0102	-0,1824 -0,1425	-0,1628	0,0047	-0,1708 -0,1546	-0,1632	0,0102	-0,1832 -0,1433	
	decile 3		-0,1154	0,0096	-0,1343 -0,0965	-0,1137	0,0051	-0,1219 -0,1056	-0,1170	0,0096	-0,1359 -0,0981	
	decile 4		-0,0517	0,0094	-0,0701 -0,0333	-0,0518	0,0045	-0,0595 -0,0441	-0,0513	0,0094	-0,0698 -0,0329	
	decile 5	*										

decile 6	0,0427	0,0093	0,0245	0,0609	0,0413	0,0046	0,0332	0,0485	0,0429	0,0093	0,0246	0,0611
decile 7	0,0905	0,0093	0,0723	0,1087	0,0882	0,0046	0,0819	0,0963	0,0900	0,0093	0,0717	0,1082
decile 8	0,1241	0,0093	0,1059	0,1424	0,1226	0,0048	0,1152	0,1310	0,1254	0,0093	0,1071	0,1438
decile 9	0,1915	0,0094	0,1730	0,2100	0,1830	0,0045	0,1748	0,1895	0,1927	0,0094	0,1742	0,2112
decile 10 (highest)	0,2516	0,0097	0,2325	0,2706	0,2342	0,0045	0,2273	0,2416	0,2524	0,0097	0,2334	0,2714
age at test time												
14 years 9 months, or less	-0,5404	0,0116	-0,5632	-0,5175	-0,5343	0,0057	-0,5429	-0,5256	-0,5525	0,0116	-0,5753	-0,5297
14 years 10 months	-0,2490	0,0168	-0,2819	-0,2160	-0,2457	0,0090	-0,2586	-0,2289	-0,2526	0,0169	-0,2856	-0,2195
14 years 11 months	-0,1320	0,0135	-0,1584	-0,1057	-0,1352	0,0067	-0,1491	-0,1258	-0,1358	0,0135	-0,1624	-0,1093
15 years 0 months	-0,0145	0,0111	-0,0363	0,0074	-0,0102	0,0049	-0,0190	-0,0030	-0,0177	0,0112	-0,0396	0,0042
15 years 1 month	0,0059	0,0109	-0,0154	0,0271	0,0070	0,0051	-0,0022	0,0145	0,0034	0,0109	-0,0179	0,0248
15 years 2 months	0,0150	0,0103	-0,0052	0,0352	0,0123	0,0051	0,0049	0,0208	0,0125	0,0103	-0,0078	0,0328
15 years 3 months	0,0057	0,0102	-0,0143	0,0257	-0,0002	0,0050	-0,0088	0,0085	0,0045	0,0103	-0,0157	0,0246
15 years 4 months												
15 years 5 months	-0,0008	0,0103	-0,0209	0,0193	-0,0020	0,0055	-0,0123	0,0070	-0,0017	0,0103	-0,0219	0,0185
15 years 6 months	-0,0047	0,0101	-0,0245	0,0152	-0,0073	0,0058	-0,0186	0,0025	-0,0062	0,0102	-0,0261	0,0138
15 years 7 months	-0,0154	0,0102	-0,0355	0,0046	-0,0242	0,0053	-0,0334	-0,0170	-0,0144	0,0103	-0,0345	0,0057
15 years 8 months	0,0014	0,0104	-0,0190	0,0217	-0,0042	0,0057	-0,0124	0,0070	-0,0001	0,0104	-0,0205	0,0204
15 years 9 months	0,0083	0,0107	-0,0127	0,0294	0,0032	0,0053	-0,0063	0,0127	0,0080	0,0108	-0,0131	0,0291
15 years 10 months	0,0334	0,0114	0,0111	0,0556	0,0278	0,0057	0,0188	0,0380	0,0343	0,0114	0,0120	0,0566
15 years 11 months	0,0466	0,0126	0,0219	0,0713	0,0427	0,0066	0,0308	0,0540	0,0476	0,0126	0,0229	0,0724
16 years 0 months, or more	0,2153	0,0137	0,1885	0,2421	0,2059	0,0069	0,1951	0,2180	0,2158	0,0137	0,1889	0,2427
number of brothers in the household												
0	-0,0986	0,0050	-0,1084	-0,0889	-0,0941	0,0022	-0,0973	-0,0902	-0,0982	0,0050	-0,1080	-0,0885
1												
2	0,0337	0,0094	0,0154	0,0521	0,0308	0,0046	0,0228	0,0395	0,0344	0,0094	0,0160	0,0527
3 or more	-0,0190	0,0214	-0,0610	0,0229	-0,0344	0,0107	-0,0518	-0,0152	-0,0119	0,0213	-0,0536	0,0299
number of sisters in the household												
0	-0,1218	0,0050	-0,1316	-0,1121	-0,1174	0,0022	-0,1214	-0,1140	-0,1209	0,0050	-0,1307	-0,1111
1												
2	0,0488	0,0098	0,0296	0,0680	0,0463	0,0055	0,0380	0,0555	0,0469	0,0098	0,0276	0,0662
3 or more	-0,0337	0,0216	-0,0761	0,0086	-0,0496	0,0104	-0,0661	-0,0309	-0,0302	0,0217	-0,0727	0,0123
test-taker lives with												
mother + father												
mother re-married	-0,1239	0,0073	-0,1382	-0,1096	-0,1167	0,0038	-0,1228	-0,1098	-0,1218	0,0073	-0,1361	-0,1075
lone mother	-0,0113	0,0069	-0,0248	0,0022	-0,0027	0,0032	-0,0083	0,0029	-0,0092	0,0069	-0,0227	0,0043
father re-married	-0,0464	0,0164	-0,0785	-0,0143	-0,0344	0,0079	-0,0479	-0,0210	-0,0458	0,0164	-0,0780	-0,0136

lone father	-0,0660	0,0131	-0,0916	-0,0403	-0,0563	0,0069	-0,0671	-0,0467	-0,0665	0,0132	-0,0923	-0,0407
other arrangements	0,0166	0,0213	-0,0251	0,0583	0,0386	0,0113	0,0191	0,0566	0,0364	0,0213	-0,0054	0,0782
Denmark	*											
the west	0,0170	0,0142	-0,0109	0,0449	0,0130	0,0068	-0,0012	0,0219	0,0154	0,0143	-0,0126	0,0435
rest-of-world	-0,2055	0,0146	-0,2341	-0,1768	-0,1938	0,0062	-0,2032	-0,1819	-0,2093	0,0147	-0,2380	-0,1805
Denmark	*											
the west	-0,0071	0,0144	-0,0353	0,0210	-0,0069	0,0084	-0,0194	0,0091	-0,0057	0,0144	-0,0339	0,0225
rest-of-world	-0,0756	0,0147	-0,1044	-0,0468	-0,0705	0,0066	-0,0824	-0,0602	-0,0769	0,0148	-0,1059	-0,0479
mother age when child born												
teenage	-0,1699	0,0163	-0,2018	-0,1380	-0,1668	0,0075	-0,1766	-0,1529	-0,1687	0,0163	-0,2006	-0,1368
20-24	-0,0863	0,0064	-0,0987	-0,0738	-0,0816	0,0030	-0,0862	-0,0762	-0,0852	0,0064	-0,0977	-0,0727
25-29	*											
30-34	0,0233	0,0058	0,0119	0,0347	0,0195	0,0026	0,0145	0,0231	0,0230	0,0058	0,0116	0,0345
35-39	0,0480	0,0091	0,0301	0,0659	0,0467	0,0046	0,0386	0,0527	0,0472	0,0091	0,0293	0,0651
40 plus	0,0615	0,0188	0,0248	0,0983	0,0597	0,0097	0,0470	0,0788	0,0569	0,0188	0,0200	0,0938
father age when child born												
teenage	-0,1527	0,0318	-0,2151	-0,0903	-0,1491	0,0155	-0,1758	-0,1221	-0,1478	0,0317	-0,2100	-0,0856
20-24	-0,0981	0,0082	-0,1141	-0,0820	-0,0897	0,0040	-0,0963	-0,0840	-0,0968	0,0082	-0,1129	-0,0808
25-29	*											
30-34	0,0144	0,0057	0,0033	0,0255	0,0141	0,0028	0,0096	0,0190	0,0139	0,0057	0,0028	0,0250
35-39	0,0249	0,0075	0,0102	0,0396	0,0237	0,0035	0,0188	0,0301	0,0254	0,0075	0,0107	0,0401
40 plus	0,0600	0,0099	0,0405	0,0794	0,0625	0,0050	0,0543	0,0707	0,0607	0,0099	0,0413	0,0802
mother labour market status												
self-employed	0,0380	0,0116	0,0153	0,0608	0,0241	0,0063	0,0132	0,0344	0,0405	0,0116	0,0177	0,0632
wage earner	*											
unemployed	-0,0949	0,0126	-0,1196	-0,0702	-0,0937	0,0057	-0,1043	-0,0854	-0,0943	0,0126	-0,1191	-0,0695
education	0,1953	0,0353	0,1262	0,2644	0,1888	0,0188	0,1558	0,2200	0,2018	0,0353	0,1325	0,2710
activation program	-0,1002	0,0150	-0,1296	-0,0707	-0,1013	0,0074	-0,1139	-0,0897	-0,0952	0,0150	-0,1245	-0,0658
welfare	-0,2448	0,0159	-0,2761	-0,2136	-0,2423	0,0071	-0,2549	-0,2302	-0,2361	0,0159	-0,2673	-0,2048
other out-of-labour-force	-0,0950	0,0088	-0,1123	-0,0777	-0,0912	0,0044	-0,0982	-0,0847	-0,0929	0,0088	-0,1102	-0,0756
father labour market status												
self-employed	0,0607	0,0074	0,0462	0,0752	0,0557	0,0035	0,0502	0,0603	0,0607	0,0074	0,0462	0,0752
wage earner	*											
unemployed	-0,0818	0,0135	-0,1083	-0,0553	-0,0806	0,0068	-0,0929	-0,0719	-0,0814	0,0136	-0,1080	-0,0548
education	0,1230	0,0858	-0,0451	0,2912	0,1004	0,0424	0,0279	0,1693	0,1312	0,0853	-0,0360	0,2984
activation program	-0,0963	0,0230	-0,1413	-0,0513	-0,0825	0,0116	-0,1038	-0,0666	-0,0992	0,0229	-0,1441	-0,0543
welfare	-0,1869	0,0191	-0,2245	-0,1494	-0,1702	0,0083	-0,1846	-0,1573	-0,1794	0,0192	-0,2169	-0,1418

mother education	other out-of-labour-force	-0,1241	0,0096	-0,1430	-0,1052	-0,1177	0,0045	-0,1248	-0,1101	-0,1246	0,0096	-0,1435	-0,1057
	missing education information	-0,5464	0,0181	-0,5818	-0,5110	-0,5193	0,0090	-0,5357	-0,5039	-0,5459	0,0181	-0,5813	-0,5105
	grundskole	-0,4994	0,0085	-0,5161	-0,4827	-0,4845	0,0040	-0,4909	-0,4786	-0,4994	0,0085	-0,5161	-0,4826
	erhvervsfaglig	-0,2861	0,0079	-0,3016	-0,2707	-0,2805	0,0033	-0,2857	-0,2752	-0,2860	0,0079	-0,3014	-0,2705
	gymnasium or KVU *												
	short tertiary	0,0006	0,0083	-0,0156	0,0168	0,0056	0,0037	-0,0011	0,0117	0,0012	0,0083	-0,0150	0,0174
	long tertiary	0,1999	0,0118	0,1768	0,2231	0,2005	0,0062	0,1898	0,2099	0,1997	0,0118	0,1765	0,2228
father education	missing education information	-0,3935	0,0174	-0,4276	-0,3594	-0,3874	0,0099	-0,4039	-0,3704	-0,3943	0,0174	-0,4285	-0,3602
	grundskole	-0,4044	0,0085	-0,4211	-0,3877	-0,3932	0,0044	-0,4014	-0,3866	-0,4048	0,0085	-0,4216	-0,3881
	erhvervsfaglig	-0,2441	0,0077	-0,2593	-0,2290	-0,2420	0,0041	-0,2488	-0,2353	-0,2453	0,0078	-0,2605	-0,2301
	gymnasium or KVU *												
	short tertiary	0,0817	0,0092	0,0637	0,0997	0,0806	0,0046	0,0733	0,0890	0,0808	0,0092	0,0628	0,0988
	long tertiary	0,1962	0,0101	0,1764	0,2160	0,1909	0,0052	0,1822	0,2003	0,1968	0,0101	0,1770	0,2166
intercept	intercept	9,3939	0,0154	9,3637	9,4240	9,3200	0,0473	9,2485	9,4089	8,7942	0,1642	8,4724	9,1160