

# Is Boys' Educational Achievement Really Low Mean, High Variance?

Stephen Machin\* and Tuomas Pekkarinen\*\*

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\* *Department of Economics, University College London and Centre for Economic Performance, London School of Economics*

\*\* *Department of Economics, Helsinki School of Economics*

## Abstract

It is often stated that there are problems with boys' educational performance across the world and that girls are doing consistently better in cognitive tests and academic examinations. It has also been noted, almost always with US data, that the variance of boys' achievement is higher so that there are more boys at both the top and bottom of the distribution of intellectual capacities. We use international data on test scores to show that one can find evidence of this low mean, high variance phenomenon in many countries in the world, but that the high variance aspect is more prevalent since mean differences are very much subject specific.

## Introduction

One controversial aspect in discussions of intellectual and cognitive abilities is whether there are significant sex differences, both in terms of average performance and in terms of variability around the average. Some research points to gender differences that favour boys, and others that favour girls (1). In some countries, superior performance by girls in school examinations and in higher rates of attendance in tertiary education have been noted (2). At the same time, some high profile remarks (like those by Lawrence Summers when President of Harvard University) have claimed there to be more males at the top of the distributions of educational success. Oft-cited examples here include there being many more male Nobel price winners and labour market evidence that men consistently get paid more than women (3).

The vast majority of evidence on sex differences in the mean and variance of intellectual and cognitive abilities is based upon American data (4). This is partly because of the availability of a number of US data sources containing test scores permit analysis. But data sources to examine the question do exist in other countries and an important, as yet unanswered, question is whether the phenomenon of 'low mean, high variance' is an accurate characterisation of boys' educational performance relative to girls.

## Method

We examined boy-girl differences in age 15 test score performance from the 2003 Programme for International Student Assessment (PISA), a survey of 15-year-olds in the principal industrialised countries. The PISA survey contains data on individual student performance for 41 countries. In our analysis we look at sex differences in mathematics and reading test scores by country, focussing on differences in the mean and variance of these test scores. The test scores are standardised to have a mean of 500 and a variance of \*\*\*.

## Results

*International Sex Differences in Mean and Variance of Reading Test Scores.* In Table 1 we show international standardised mean differences in reading test scores (defined as the sex difference in means divided by the standard deviation) and differences in variance, shown by the male-to-female variance ratio. The low mean, high variance phenomenon in reading test scores is very clear. In all 41 countries, the boy-girl mean difference is negative and in 40 out of 41 the boy-girl variance ratio exceeds unity.

*International Sex Differences in Mean and Variance of Mathematics Test Scores.* Table 2 shows the same comparisons for mathematics. Here the mean differences tend to favour boys, but again the higher variance ratio is observed almost everywhere for boys. In 38 out of 41 countries the variance ratio is above 1.

*The Extent of Over-Representation of Boys at the Top and Bottom of the Test Score Distribution.* Table 3 shows the relative prevalence of boys in top 10% and bottom 10% of the maths and reading test score distributions. It reports the ratios of boys to girls in these parts of the distribution. There are differences for the two tests. For mathematics, it is evident that boys are over-represented at the top and the gap is more or less the same at the bottom: in 39 of the 41 countries there are more boys in the top 10% and in 21 countries there are more boys in the bottom 10%. For reading, the pattern is reversed, with all countries having more boys in the bottom 10% and 40 out of 41 having more girls in the top 10%.

*The Cross-Country Relation Between Variance Ratios and Test Score Performance.* Figure 1 plots the boy-girl variance ratio against the mean test score performance for the 41 countries, for reading and mathematics tests. A clear positive association emerges. In countries with better test score performance the boy-girl variance ratio is significantly higher.

## Implications and Conclusions

Analysis of PISA 2003 data confirms that the high variance aspect of the 'low mean, high variance' phenomenon is a salient feature of reading and mathematics performance in 41 countries. In almost all comparisons the age 15 boy-girl variance in test scores is present. Similarly, this variance is seen to be higher in countries which have higher levels of test score performance.

Sex differences in means are less hard to characterise since it is evident in the PISA data that boys do better in mathematics, whilst girls do better in reading. This clearly has a compositional effect on the variance differences as well, as it emerges

that the higher boy-girl variance in mathematics come about because of an increased prevalence of boys in the upper part of the distribution, but the higher variance in reading is due to a greater preponderance of boys in the bottom part of the test score distribution.

Thus there is some truth in the question asked in the title of this article, but the notion that boys do worse on average and more men appear in the upper part of the distribution is clearly subject-specific. Boys do show more variability in educational performance, but the extent to which they do and the way in which it emerges across the distribution is a function of the academic subject being studied and tested.

#### Endnotes and References

To be added

(1)

Table 1 Standardised mean differences in reading test scores and the male-female variance ratios

Country	Difference	Variance ratio
Australia	-0.40 (0.04)	1.25 (0.00)
Austria	-0.46 (0.05)	1.23 (0.00)
Belgium	-0.34 (0.05)	1.23 (0.00)
Brazil	-0.31 (0.03)	1.23 (0.00)
Canada	-0.36 (0.02)	1.26 (0.00)
Czech Republic	-0.33 (0.05)	1.05 (0.17)
Denmark	-0.29 (0.03)	1.11 (0.01)
Finland	-0.54 (0.03)	1.26 (0.00)
France	-0.39 (0.05)	1.22 (0.00)
Germany	-0.39 (0.04)	1.19 (0.00)
Greece	-0.36 (0.04)	1.33 (0.00)
Hong Kong	-0.37 (0.07)	1.45 (0.00)
Hungary	-0.34 (0.04)	1.11 (0.01)
Iceland	-0.59 (0.04)	1.31 (0.00)
Indonesia	-0.32 (0.04)	1.00 (0.88)
Ireland	-0.34 (0.05)	1.09 (0.07)
Italy	-0.39 (0.06)	1.31 (0.00)
Japan	-0.21 (0.05)	1.25 (0.00)
Korea	-0.26 (0.07)	1.09 (0.02)
Latvia	-0.43 (0.05)	1.25 (0.00)
Lichtenstein	-0.19 (0.13)	1.18 (0.28)
Luxembourg	-0.33 (0.03)	1.23 (0.00)
Macau-China	-0.20 (0.07)	1.18 (0.04)
Mexico	-0.23 (0.05)	1.07 (0.00)
Netherlands	-0.25 (0.05)	1.08 (0.10)
New Zealand	-0.26 (0.04)	1.14 (0.00)
Norway	-0.48 (0.04)	1.26 (0.00)
Poland	-0.41 (0.04)	1.29 (0.00)
Portugal	-0.39 (0.04)	1.31 (0.00)
Russian Federation	-0.31 (0.04)	1.28 (0.00)
Slovakia	-0.35 (0.04)	1.08 (0.03)
Spain	-0.41 (0.04)	1.25 (0.00)
Sweden	-0.38 (0.03)	1.11 (0.01)
Switzerland	-0.37 (0.05)	1.15 (0.00)
Thailand	-0.55 (0.05)	1.17 (0.00)
Tunisia	-0.26 (0.04)	1.01 (0.77)
Turkey	-0.35 (0.06)	1.28 (0.00)
United Kingdom	-0.30 (0.05)	1.13 (0.00)
United States	-0.32 (0.03)	1.17 (0.00)
Uruguay	-0.32 (0.04)	1.20 (0.00)
Serbia	-0.53 (0.05)	1.28 (0.00)

Note: Difference refers to male-female difference in means divided by standard deviation of the test score. Standard error of the difference estimate is reported within parentheses. Variance ratio refers to the male/female ratio of test score variances. P-value for the test of the equality of variance is reported within parentheses.

Table 2 Standardised mean differences in mathematics test scores and the male-female variance ratios

Country	Difference		Variance ratio	
Australia	0.06	(0.04)	1.18	(0.00)
Austria	0.08	(0.05)	1.20	(0.00)
Belgium	0.07	(0.04)	1.19	(0.00)
Brazil	0.16	(0.04)	1.20	(0.00)
Canada	0.13	(0.02)	1.24	(0.00)
Czech Republic	0.16	(0.05)	1.07	(0.05)
Denmark	0.18	(0.04)	0.99	(0.85)
Finland	0.09	(0.03)	1.22	(0.00)
France	0.09	(0.05)	1.19	(0.00)
Germany	0.09	(0.04)	1.12	(0.01)
Greece	0.21	(0.04)	1.23	(0.00)
Hong Kong	0.04	(0.07)	1.36	(0.00)
Hungary	0.08	(0.04)	1.10	(0.02)
Iceland	-0.17	(0.04)	1.24	(0.00)
Indonesia	0.04	(0.04)	0.95	(0.04)
Ireland	0.17	(0.05)	1.07	(0.15)
Italy	0.19	(0.06)	1.27	(0.00)
Japan	0.08	(0.06)	1.29	(0.00)
Korea	0.25	(0.07)	1.10	(0.02)
Latvia	0.03	(0.05)	1.19	(0.00)
Lichtenstein	0.29	(0.11)	1.38	(0.04)
Luxembourg	0.19	(0.03)	1.16	(0.00)
Macau-China	0.24	(0.07)	1.26	(0.00)
Mexico	0.13	(0.05)	1.08	(0.00)
Netherlands	0.06	(0.05)	1.00	(0.91)
New Zealand	0.15	(0.04)	1.16	(0.00)
Norway	0.07	(0.03)	1.19	(0.00)
Poland	0.06	(0.03)	1.27	(0.00)
Portugal	0.14	(0.04)	1.30	(0.00)
Russian Federation	0.11	(0.05)	1.20	(0.00)
Slovakia	0.20	(0.04)	1.10	(0.00)
Spain	0.10	(0.03)	1.20	(0.00)
Sweden	0.07	(0.03)	1.10	(0.03)
Switzerland	0.17	(0.05)	1.11	(0.00)
Thailand	-0.05	(0.05)	1.10	(0.01)
Tunisia	0.15	(0.03)	1.03	(0.52)
Turkey	0.14	(0.06)	1.22	(0.00)
United Kingdom	0.07	(0.05)	1.06	(0.04)
United States	0.07	(0.03)	1.19	(0.00)
Uruguay	0.12	(0.04)	1.10	(0.01)
Serbia	0.01	(0.05)	1.30	(0.00)

Note: Difference refers to male-female difference in means divided by standard deviation of the test score. Standard error of the difference estimate is reported within parentheses. Variance ratio refers to the male/female ratio of test score variances. P-value for the test of the equality of variance is reported within parentheses.

Table 3 Ratio of men to women below 10<sup>th</sup> and above 90<sup>th</sup> percentiles of the test score distributions

Country	Below 10%, reading	Above 90%, reading	Below 10%, math	Above 90%, math
Australia	2.37	0.57	1.12	1.39
Austria	2.93	0.50	1.13	1.59
Belgium	2.30	0.60	1.24	1.64
Brazil	1.86	0.58	0.71	1.42
Canada	2.36	0.56	1.08	1.48
Czech Republic	2.19	0.61	0.85	1.52
Denmark	1.74	0.57	0.72	1.36
Finland	2.90	0.39	1.04	1.46
France	2.21	0.47	0.97	1.38
Germany	2.08	0.57	0.91	1.43
Greece	2.41	0.62	0.84	1.83
Hong Kong	2.36	0.63	1.20	1.58
Hungary	2.16	0.65	1.06	1.48
Iceland	4.18	0.40	1.86	0.99
Indonesia	1.78	0.55	0.91	1.07
Ireland	2.05	0.57	0.85	1.70
Italy	2.80	0.55	0.88	1.61
Japan	1.88	0.77	1.18	1.61
Korea	2.63	0.86	1.14	2.35
Latvia	2.52	0.50	1.00	1.25
Lichtenstein	1.68	0.91	0.79	2.56
Luxembourg	2.08	0.63	0.83	1.74
Macau-China	1.88	0.69	1.05	1.44
Mexico	1.47	0.67	0.72	1.32
Netherlands	1.62	0.66	0.85	1.18
New Zealand	1.97	0.72	1.05	1.67
Norway	3.03	0.47	1.16	1.41
Poland	2.75	0.56	1.21	1.47
Portugal	2.39	0.60	0.98	1.63
Russian Federation	2.10	0.71	0.90	1.48
Slovakia	2.32	0.56	0.93	1.76
Spain	2.68	0.57	1.09	1.47
Sweden	2.17	0.50	1.01	1.38
Switzerland	2.08	0.58	0.87	1.96
Thailand	2.71	0.43	0.98	0.82
Tunisia	1.48	0.62	0.72	1.25
Turkey	3.64	1.08	1.26	2.20
United Kingdom	2.01	0.61	0.99	1.27
United States	2.07	0.62	1.12	1.39
Uruguay	2.48	0.69	1.00	1.46
Serbia	3.35	0.51	1.24	1.63

Table x Standardised gender difference at the 10<sup>th</sup> and 90<sup>th</sup> quantiles of the reading test scores

Country	Difference at 10%		Difference at 90%	
Australia	-0.66	(0.05)	-0.28	(0.03)
Austria	-0.68	(0.06)	-0.28	(0.04)
Belgium	-0.59	(0.06)	-0.22	(0.02)
Brazil	-0.48	(0.06)	-0.19	(0.05)
Canada	-0.59	(0.04)	-0.23	(0.02)
Czech Republic	-0.38	(0.08)	-0.28	(0.04)
Denmark	-0.43	(0.07)	-0.24	(0.04)
Finland	-0.86	(0.05)	-0.45	(0.03)
France	-0.58	(0.07)	-0.31	(0.03)
Germany	-0.51	(0.07)	-0.22	(0.04)
Greece	-0.71	(0.06)	-0.18	(0.04)
Hong Kong	-0.75	(0.08)	-0.23	(0.03)
Hungary	-0.45	(0.06)	-0.29	(0.04)
Iceland	-0.88	(0.06)	-0.48	(0.04)
Indonesia	-0.34	(0.05)	-0.39	(0.05)
Ireland	-0.46	(0.06)	-0.24	(0.04)
Italy	-0.67	(0.05)	-0.22	(0.03)
Japan	-0.43	(0.06)	-0.10	(0.03)
Korea	-0.41	(0.06)	-0.25	(0.04)
Latvia	-0.62	(0.06)	-0.30	(0.05)
Lichtenstein	-0.44	(0.24)	-0.24	(0.14)
Luxembourg	-0.57	(0.07)	-0.19	(0.04)
Macau-China	-0.26	(0.11)	-0.04	(0.11)
Mexico	-0.31	(0.06)	-0.16	(0.04)
Netherlands	-0.32	(0.06)	-0.21	(0.04)
New Zealand	-0.35	(0.06)	-0.16	(0.04)
Norway	-0.66	(0.06)	-0.38	(0.05)
Poland	-0.68	(0.05)	-0.29	(0.05)
Portugal	-0.64	(0.06)	-0.24	(0.04)
Russian Federation	-0.58	(0.06)	-0.14	(0.04)
Slovakia	-0.50	(0.05)	-0.31	(0.03)
Spain	-0.64	(0.06)	-0.27	(0.04)
Sweden	-0.48	(0.05)	-0.33	(0.05)
Switzerland	-0.50	(0.05)	-0.26	(0.04)
Thailand	-0.73	(0.05)	-0.44	(0.05)
Tunisia	-0.25	(0.05)	-0.29	(0.05)
Turkey	-0.55	(0.05)	-0.17	(0.08)
United Kingdom	-0.47	(0.05)	-0.24	(0.04)
United States	-0.39	(0.07)	-0.23	(0.04)
Uruguay	-0.53	(0.06)	-0.21	(0.04)
Serbia	-0.77	(0.05)	-0.39	(0.05)

Table xx Standardised gender difference at the 10<sup>th</sup> and 90<sup>th</sup> quantiles of the mathematics test scores

Country	Difference at 10%		Difference at 90%	
Australia	-0.08	(0.05)	0.20	(0.03)
Austria	-0.09	(0.06)	0.27	(0.05)
Belgium	-0.05	(0.06)	0.17	(0.03)
Brazil	0.07	(0.05)	0.37	(0.06)
Canada	-0.07	(0.04)	0.28	(0.03)
Czech Republic	0.13	(0.05)	0.28	(0.04)
Denmark	0.16	(0.06)	0.14	(0.05)
Finland	-0.10	(0.05)	0.21	(0.05)
France	-0.12	(0.07)	0.20	(0.05)
Germany	0.03	(0.06)	0.18	(0.05)
Greece	0.10	(0.05)	0.34	(0.05)
Hong Kong	-0.22	(0.06)	0.23	(0.04)
Hungary	0.01	(0.05)	0.18	(0.05)
Iceland	-0.36	(0.06)	-0.01	(0.06)
Indonesia	0.09	(0.05)	-0.07	(0.06)
Ireland	0.17	(0.06)	0.25	(0.05)
Italy	0.08	(0.05)	0.36	(0.03)
Japan	-0.07	(0.06)	0.29	(0.04)
Korea	0.15	(0.05)	0.27	(0.05)
Latvia	-0.06	(0.06)	0.19	(0.05)
Lichtenstein	0.34	(0.26)	0.34	(0.17)
Luxembourg	0.11	(0.06)	0.32	(0.06)
Macau-China	-0.03	(0.14)	0.32	(0.11)
Mexico	0.07	(0.06)	0.21	(0.05)
Netherlands	0.08	(0.07)	0.10	(0.04)
New Zealand	0.02	(0.06)	0.26	(0.04)
Norway	-0.09	(0.05)	0.20	(0.06)
Poland	-0.14	(0.05)	0.25	(0.06)
Portugal	-0.10	(0.05)	0.31	(0.05)
Russian Federation	0.01	(0.05)	0.27	(0.05)
Slovakia	0.11	(0.05)	0.31	(0.04)
Spain	-0.03	(0.06)	0.21	(0.04)
Sweden	0.01	(0.06)	0.16	(0.05)
Switzerland	0.12	(0.06)	0.30	(0.05)
Thailand	-0.10	(0.04)	0.08	(0.06)
Tunisia	0.17	(0.04)	0.18	(0.07)
Turkey	-0.01	(0.06)	0.30	(0.08)
United Kingdom	-0.01	(0.05)	0.08	(0.05)
United States	-0.06	(0.06)	0.17	(0.05)
Uruguay	0.09	(0.05)	0.20	(0.05)
Serbia	-0.09	(0.05)	0.31	(0.05)



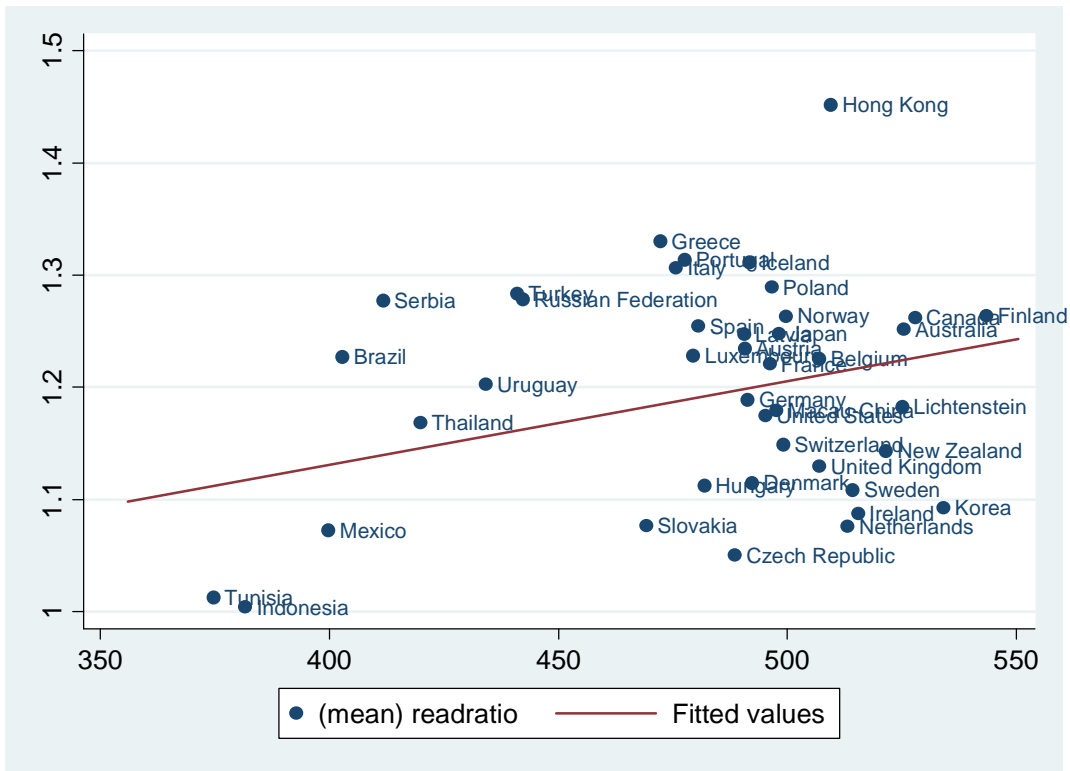


Figure 1a Male/female variance ratio and mean test score in reading. Linear regression curve weighted with national sample sizes.

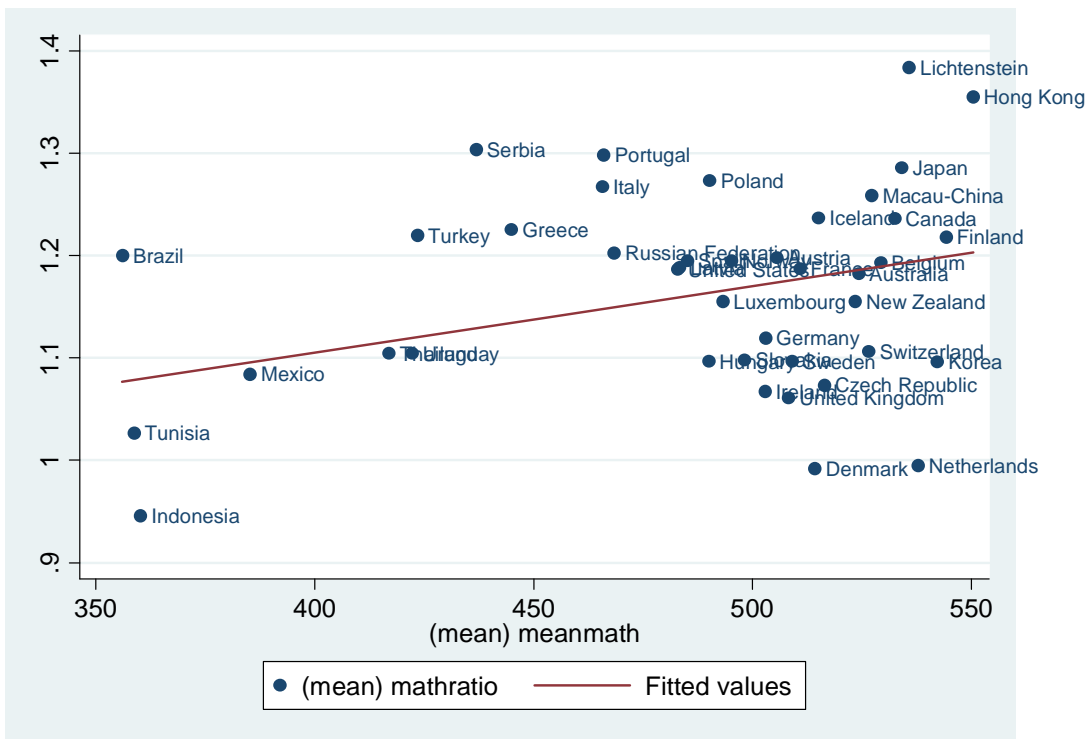


Figure 1b Male/female variance ratio and mean test score in mathematics. Linear regression curve weighted with national sample sizes.