The Gender Maths Gap and Single-Sex Schooling

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Ollscoil na hÉireann Má Nuad

Gender Differences in Mathematics

- There is a significant gender difference in maths scores in many countries

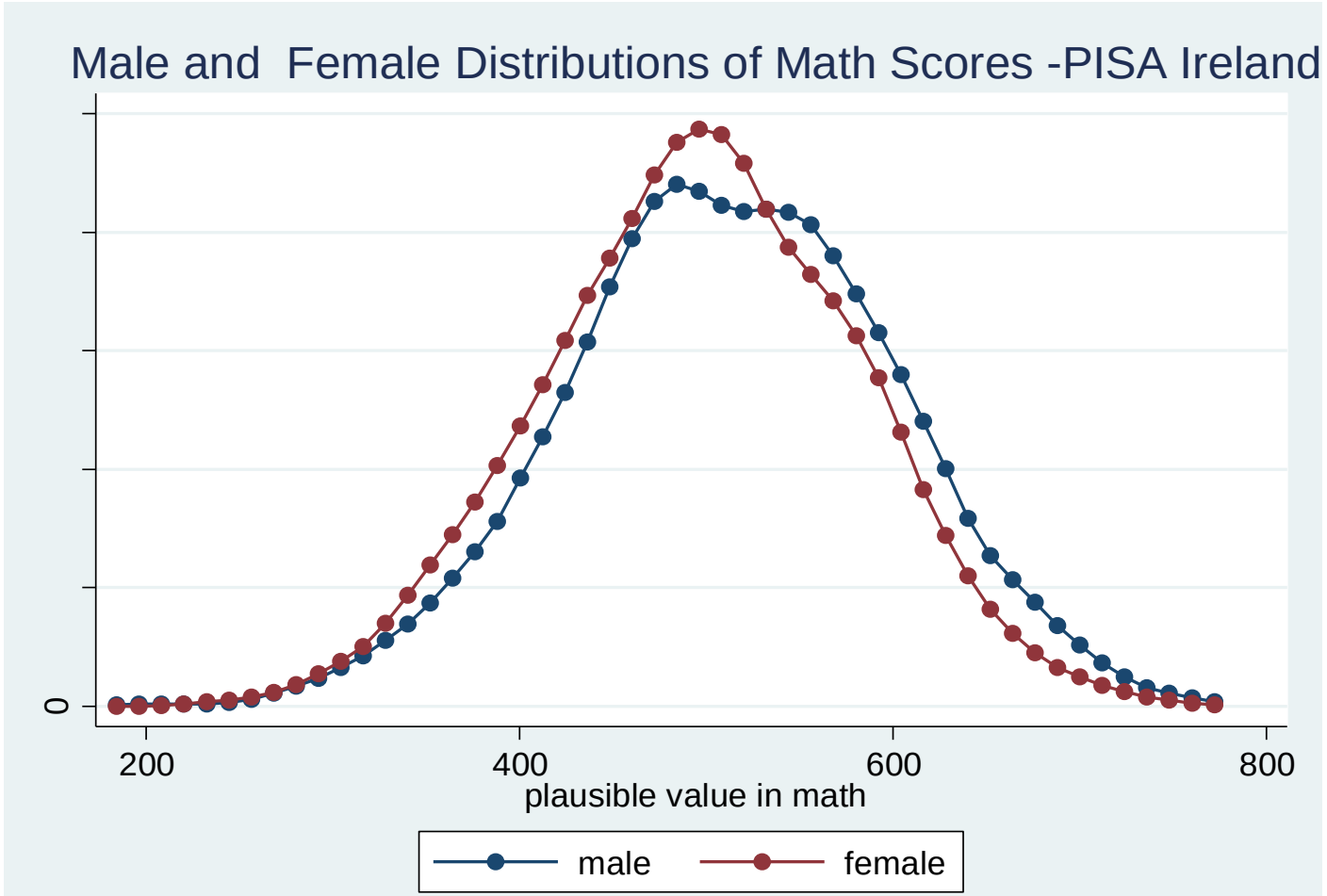
- Boys tend to out-perform girls, particularly at the upper end of the distribution

PISA

- Programme for International Student Assessment (PISA)
  - an internationally standardized assessment
  - assesses competencies rather than knowledge of curriculum
  - administered to 15-year-olds in schools in OECD countries
  - 2003: focussed on maths performance

Average Male-Female Differential in Maths Scores, PISA 2003

Austria	19
Belgium	18
Canada	20
Czech Rep	30
Denmark	16
Finland	2
France	18
Germany	11
Greece	19
Hungary	15
Iceland	-15
Ireland	25
Italy	18
Netherlands	8
New Zealand	18
Norway	7
Poland	13
Portugal	15
Slovenia	35
Spain	18
Sweden	10
Switzerland	25
US	15
OECD	17


Male and Female Distributions of Math Scores -PISA Ireland
0
200
400
600
800
plausible value in math
male
female

Should We Particularly Care About Maths?

- ‘Smart Economy’ Policy Objective: need to raise maths achievement
- Gender Equality Policy Objective: observed difference in maths performance between women and men accounts for a large proportion of the gender wage gap (Paglin and Rufolo, 1990)

The Focus of Our Paper

The question we ask in this paper is:

"Could more single-sex schooling reduce the gender maths differential?"

Fryer and Levitt (2010)

- Used an early childhood longitudinal study, the ECLS-K
- Found that kindergarten girls and boys are equivalent in both maths and reading
- By the end of 5th grade (age 10-11), girls have fallen more than 0.2 standard deviations behind their male counterparts in maths
- Unable to explain the gap

Fryer and Levitt II

- Noted that the gender maths gap was largest in southern US states, almost non-existent in some eastern states
- Speculated that gap largest where belief in traditional roles of men and women strongest
- Turned to cross-country analysis to examine whether the same pattern exists in international data
- Used the World Economic Forum (WEF) gender gap index as a measure of gender inequality
  - Reflects economic and political opportunities, education and well being for women

Fryer and Levitt III

- First looked at relationship between PISA gender test score gap and WEF index
- Strong positive relationship between relative maths performance of girls and gender equality
- Then looked at relationship between WEF and relative performance of girls in TIMSS, another international maths assessment
- Positive relationship between girls' performance and equality broke down

Fryer and Levitt IV

- Difference in results is driven by the fact that TIMSS includes a large number of Middle Eastern countries not in PISA
- Although these countries have a high degree of gender inequality, there is no gender gap in maths
- In many of these countries, same-sex classrooms or schools are prevalent
- Led Fryer and Levitt to speculate that same-sex education may reduce the gender maths gap

Policy Relevance

- In recent years, schools in the US and the UK have been experimenting with having single-sex classes within mixed schools
- Should this be encouraged?

Why Would Single-Sex Education Affect the Gender Maths Gap?

- Differential treatment of male and female students by teachers may perpetuate stereotypes of gender roles
- Single-sex education may increase self-esteem in girls
  - Some evidence that girls who go to single-sex schools are less likely to hold stereotypical views of gender roles later in life
- Different responses to competition
  - Women may dislike competing against men
  - This reluctance to compete may be more important for performance in maths than in other subjects

Research on Single-Sex Education

- Problems in research on single-sex education:
  - Small samples
  - Fact that students self-select into single-sex and mixed-sex schools
- Ireland a particularly useful laboratory:
  - A sizeable proportion of students attend single-sex schools
  - Unlike other countries, most of the single sex schools are not private

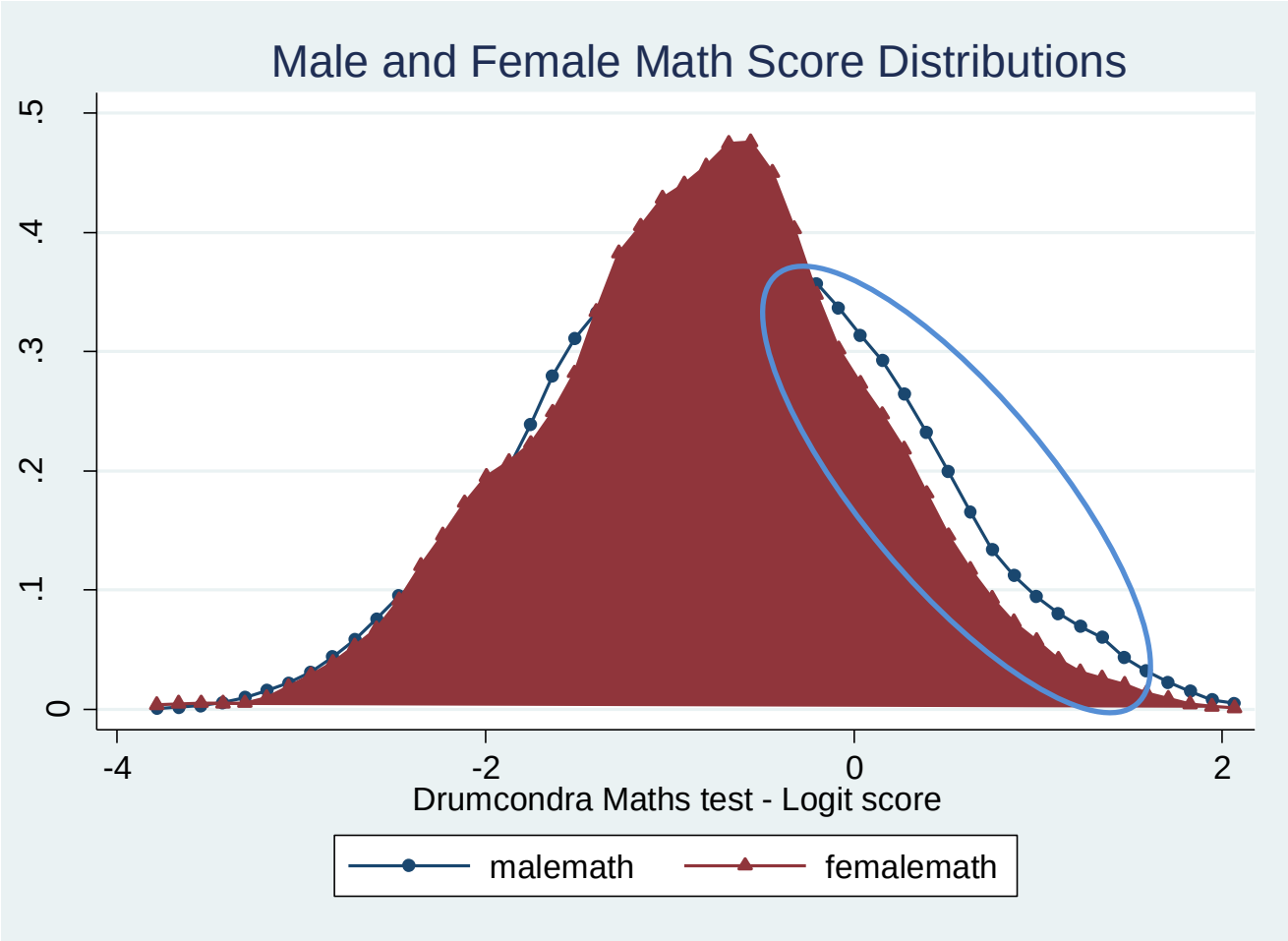
Single-Sex Schooling in Ireland: Primary Level

	GUI Sample - 9 year olds		Dept of Education Statistics	
	Boys	**Girls**	**Boys**	**Girls**
Single Sex	.29	.19	.22	.17
Mixed	.71	.70	.75	.73
Mixed Infants		.11	.03	.10

Single-Sex Schooling in Ireland: Second Level

	PISA Sample - 15 year olds (2003)		Dept of Education Statistics (2004)	
	Boys	**Girls**	**Boys**	**Girls**
Single Sex	.39	.51	.33	.43
Mixed	.61	.49	.67	.57

GUI: Distribution of Maths Scores



GUI: Male and Female Maths Scores

	Mean	10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile
Male	-0.70	-1.97	-1.40	-0.69	-0.01	0.56
Female	-0.81	-2.01	-1.38	-0.79	-0.25	0.31

Quantile Regressions for Maths Score (mathsls)

	25th Percentile	50th Percentile	75th Percentile
Constant	-1.38 (.024)	-0.788 (.023)	-0.244 (.026)
Male	-0.019 (.034)	0.103* (.031)	0.236* (.036)
No. Obs.	8439	8439	8439

Quantile Regression of Maths Score at 75th Percentile

Constant	-0.244 (.026)	-0.229 (.026)
Male	0.236* (.036)	0.173* (.035)
All Boys		0.119* (.045)
All Girls		-0.054 (.046)
No. Obs.	8439	8436

- Male-Female Difference in Mixed Schools: 0.173
- Male-Female Difference Single-Sex Schools:

  0.173+0.119+0.054=0.346
- Single-Sex Effect for Boys: 0.119
- Single-Sex Effect for Girls: -0.054 (not significant)

Results Summary

- With no controls for single-sex schooling, the male-female gap at the 75th percentile is 0.24
- If single-sex schooling reduces the maths gap (as speculated by Fryer and Levitt), we expect:
  - girls to perform better in single-sex schools
  - the girls' single-sex premium to be bigger than any boys' single-sex premium
- In fact, single-sex schooling has *no* effect on girls' scores, and a large positive effect on boys' scores
- As a result, the maths gap in single-sex schools is 0.35, compared to 0.17 in mixed schools
- Single-sex schooling does *not* reduce the maths gap

Is Attendance at Single-Sex School Exogenous?

- Previous analysis assumes that whether child attends a single-sex or mixed school is exogenous
- Anecdotal evidence suggests that most parents choose the nearest school
  - in this case, can treat assignment to single-sex or mixed school as random
- To test exogeneity assumption, we modelled the choice of school

	Boys	Girls
Constant	-1.339* (.097)	-0.788* (.093)
Income/1000	0.001 (.001)	-0.001 (.001)
Parent Degree	-0.145* (.054)	-0.171* (.059)
No School Choice	-0.365* (.089)	-0.603* (.101)
Mixed Siblings	-0.019 (.046)	-0.285* (.047)
Border	0.063 (.116)	-0.017 (.107)
Dublin	0.606* (.105)	0.004 (.099)
Mid-East	0.668* (.109)	0.125 (.107)
Midland	0.559* (.126)	0.147 (.123)
Mid-West	0.550* (.109)	-0.339 (.116)
South-East	0.716* (.113)	0.631* (.103)
South-West	0.990* (.103)	0.439* (.100)
Urban	0.561* (.053)	0.848* (.055)
N	3652	3894

Probit Models of Choice of Single-Sex School

	mathsls
Male	0.100* (.040)
All Boys School	0.086 (.052)
All Girls School	-0.107* (.053)
Household Income/1000	-0.002* (.001)
Parent Has Degree	0.190* (.040)
Household Class: Professional/Managerial	0.308* (.063)
Household Class: Skilled Manual	0.088 (.062)
Father Present	0.102 (.057)
Family Size	-0.022 (.116)
Study Child in 3rd Class	0.213* (.036)
Study Child in 4th Class	0.534* (.071)
Constant	-0.704* (.089)
N	7117

Quantile Regression of Maths Score at 75th Percentile

Conclusions

- There is a male advantage in maths performance at the top of the distribution of Irish 9 year olds
- Single-sex schooling does not reduce this male advantage; if anything, it exacerbates it
- In Ireland, attendance at a single-sex primary school is largely random, so the effect of single-sex schooling can be tested convincingly
- Adding other explanatory variables to the model reduces the male advantage, but does not eliminate it

Different Responses to Competition? Gneezy et al. (2003)

- Conducted experiments using Israeli high-school students, comparing performances on mathematical puzzles under different reward structures:
  - Piece-rate payment – reward based on number completed
  - Tournament-based payment – reward affected by performance of competitors
- Gender gap in performance much higher in the tournament than in the piece-rate system

Gneezy et al. II

- Women also less likely than men to choose a tournament, if given choice
- If reference group in tournament was single sex, performance gap between men and women lower than in mixed-sex tournaments
- Conclude that “it is not the case that women in this study generally are unwilling or unable to perform well in competitions but rather they do not compete well in competitions against men”