The Timing of Education Inequality: When and How Gender Gaps in Maths Skills Emerge and Evolve

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Research Question

Why do boys tend to outperform girls in Maths at the end of secondary school?

What is this study about?

This study explores the development of gender gaps in Leaving Certificate Maths by examining:

- The roles of differing skills/background (endowments) versus differing returns to those traits (coefficients)
- How these contributions change between childhood (age 9) and adolescence (age 13)
- The influence of family structure, particularly paternal involvement
- Whether sustained father absence impacts boys and girls differently

Method: How Do I Do This?

- **Oaxaca-Blinder decomposition:** Compares regression models across groups (e.g., boys vs. girls, father present vs. absent) to answer: *"What would happen if Group A had the same characteristics as Group B?"*
  - Splits the outcome gap into:
    - **Endowments:** How much of the gap is due to differences in observable traits (e.g., skills, SES)? $\Rightarrow$ What they bring to the table
    - **Coefficients:** Even with equal traits, are they valued differently? Do the same skills yield different outcomes?$\Rightarrow$ How the system/environment responds to those traits

Method: How Do I Do This?

- **Oaxaca-Blinder decomposition:**
  - Applied to both gender and father absence gaps
  - Allows comparison of gap composition at age 9 and age 13
  - Helps identify when and where key divergences emerge
- **What I estimate:**
  - Gender gaps (Girls vs. Boys)
  - Father absence effects (Father Present vs. Absent), separately for boys and girls

Data and Variables

Event	Date	Age (in years)	Variables of interest
Study-child is born	Nov/97 - Oct/98	0	-
Wave 1 data collection	Aug/07 - May/08	9	2 Cognitive variables (Reading and Maths logit scores), 4 SDQ scales, Parental Education (mother and father's), Income quintiles, 1 School Indicator (CoEd)
Wave 2 data collection	Aug/11 - Mar/12	13	3 Cognitive variables (Verbal and Numerical logit scores, BAS Matrices), 4 SDQ scales, Parental Education (mother and father's), Income quintiles, 4 School Indicators (DEIS, CoEd, Fee-paying, Religious Ethos)
Study-child sits the Junior Cert	Jun/13 - Jun/15	15–16	-
Wave 3 data collection	Apr/15 - Aug/16	17/18	Most participants had *not yet sat* the Leaving Cert
Study-child sits the Leaving Cert	Jun/16 - Jun/17	17/18	-
Wave 4 data collection	Aug/18 - Jun/19	20	Leaving Cert points in Maths scores

Table: Timeline of Events - Growing Up in Ireland '98 Cohort

Note: The Leaving Certificate grading system changed in 2017. Scores were harmonized across the old (A1-F) and new (H1-H8) schemes to ensure comparability.

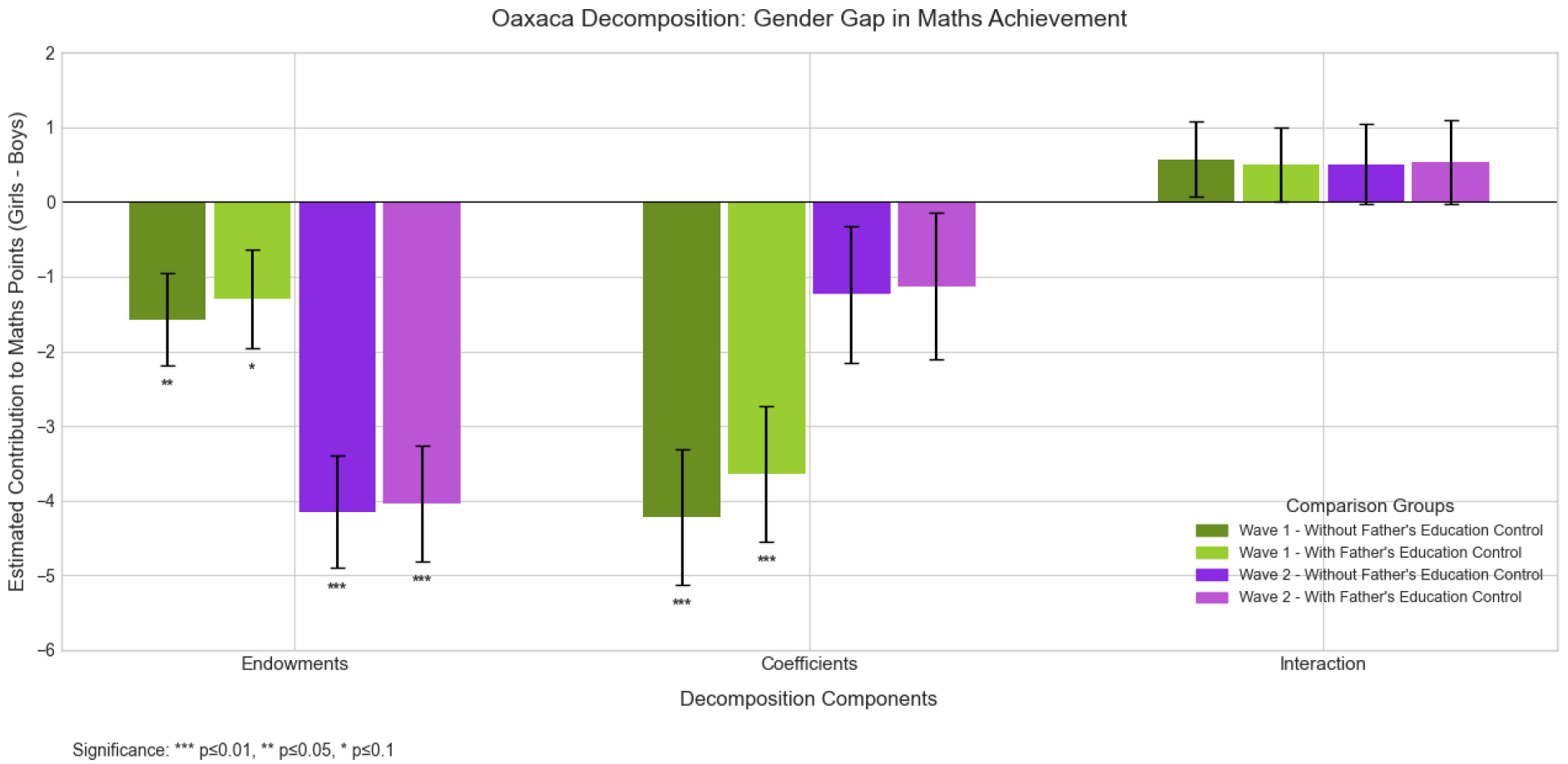
Why does this matter for us?

- Early-life cognitive and noncognitive skills are critical inputs in the human capital production function.
- I examine how the same traits are rewarded differently across gender and family structure $\rightarrow$ a central question in the economics of education and labour markets.
- Pinpointing when gaps emerge allows for better-targeted interventions $\rightarrow$ where and when they matter most.
- Parental education and father absence shape skill development. Understanding these pathways informs debates on inequality and social mobility.
- Structural shifts in the labour market have made school success more important. Boys' underachievement mattered less in the past, but now, falling behind in education has long-term costs.

Decomposition Design: Gender Gap

- I examine gender gaps in Maths scores at age 17/18 using predictors from:
  - **Wave 1 (Age 9)** – childhood traits
  - **Wave 2 (Age 13)** – early adolescence traits
- For each wave, I estimate two models:
  - *Model A:* Excludes father's education
  - *Model B:* Includes father's education
- Aim: Assess whether the gap is driven by:
  - **Endowments:** Different traits across genders
  - **Coefficients:** Same traits rewarded differently
- This design helps identify when the gap solidifies: *Do early differences in treatment later manifest as skill gaps?*

Gender Gaps in Maths Achievement



Significance: *** p≤0.01, ** p≤0.05, * p≤0.1

Gender Gaps Change Over Time

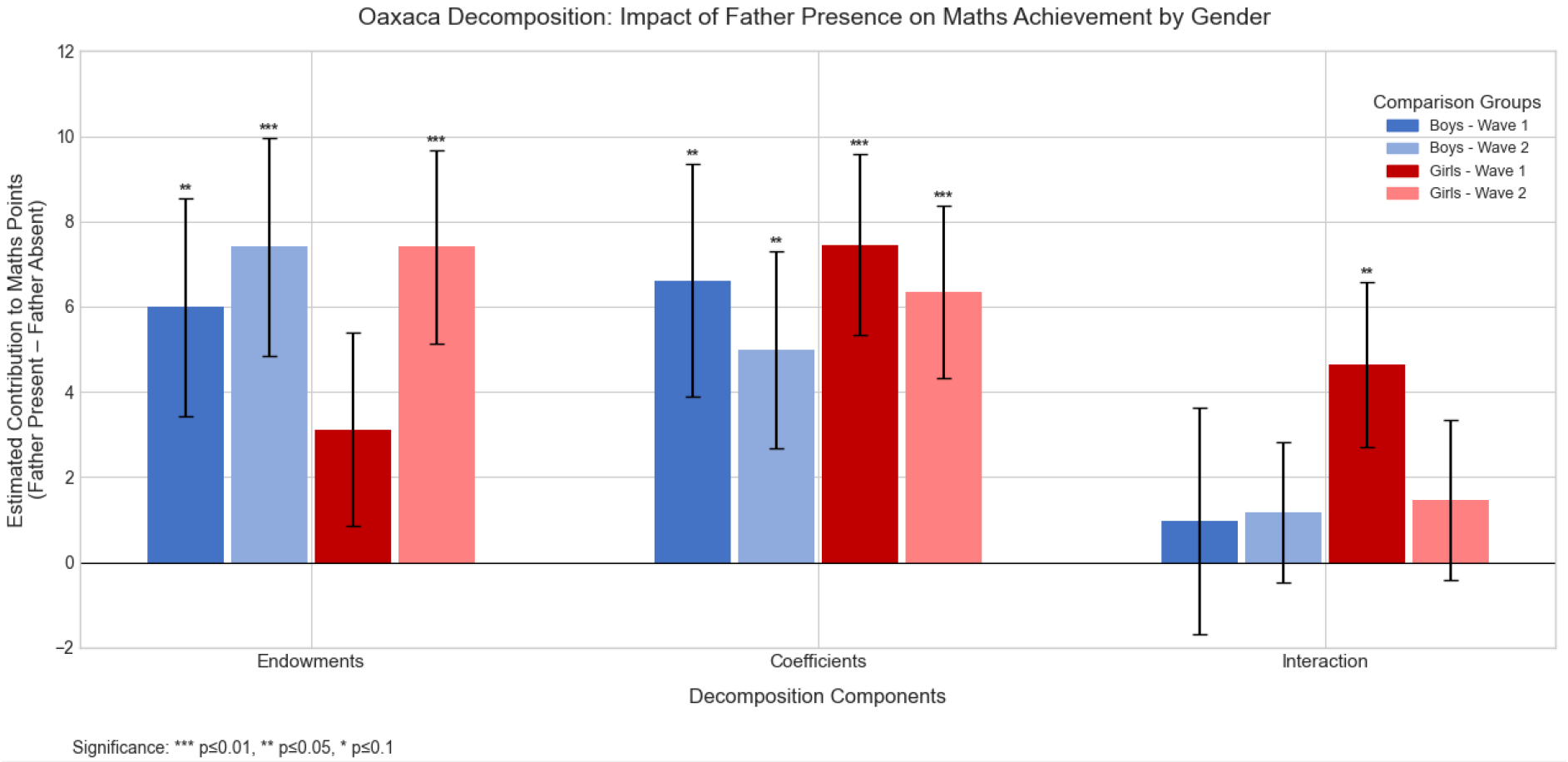
- Boys outperform girls in Maths by 4.4–5.2 points on average.
- **At age 9 (Wave 1)**: Most of the gap comes from *coefficients* — girls' skills are rewarded less.
  - Coefficients effect: –4.21 points ($p < 0.01$)
- **At age 13 (Wave 2)**: Most of the gap comes from *endowments* — boys now have stronger cognitive skills.
  - Endowments effect: –4.15 points ($p < 0.01$)
- **Strongest contributors**:
  - Age 9: Maths ability (–1.89 points)
  - Age 13: Numerical ability (–3.66 points)
- Suggests a transition from unequal treatment $\rightarrow$ real skill differences by adolescence.

Decomposition Design: Father Absence

- I compare students with and without a consistently **absent father**:
  - Absence = father did not respond in both Wave 1 and Wave 2
  - Captures sustained paternal disengagement
- I run separate decompositions for:
  - **Boys** and **Girls**
  - Using Wave 1 and Wave 2 predictors
- The goal is to understand:
  1. Whether father absence affects boys and girls differently
  2. Which mechanisms (skills vs. returns) drive these effects
  3. Whether maternal education compensates in some sense

Note: About 80% of absent cases involve no resident father; 20% involve disengaged but present fathers. Wave 3 confirms low paternal engagement in these households. Attrition is higher in the father-absent group, making effect estimates conservative. These students also show lower SES, cognitive, and socioemotional scores, justifying decomposition.

Impact of Father Presence on Maths Achievement



Father Absence Affects Boys and Girls Differently

- Father absence is linked to large Maths penalties:
  - Boys: –13.6 points
  - Girls: –15.2 points
- **Boys**: Both *endowments* and *coefficients* drive the penalty at both ages.
- **Girls**: Mostly *coefficients* at age 9 (–7.46 pts) + interaction effects, more balanced by age 13.
- These differences align with findings from developmental and behavioural economics:
  - Boys more vulnerable to family instability
  - Girls benefit more from sustained family resources and support

Key Findings: The Evolving Gender Gap in Maths

- **The Story Changes with Age:** Boys consistently outperform girls in Leaving Cert Maths, but *why* changes significantly.
  - **At Age 9 (Childhood):** The gap is mainly due to *different returns* to skills (i.e., how skills are rewarded).
  - **By Age 13 (Adolescence):** The gap is primarily explained by *differences in actual skills* (boys having higher average numerical ability).
- **Early Treatment Matters:** Initial differences in how skills are valued seem to become real skill differences over time.
- **Cognitive Skills are Key:** Numerical ability, in particular, becomes a dominant factor in the gap by early adolescence.
- **Potential Mechanisms (Why the shift?):** Factors like teacher expectations, peer dynamics, stereotype threat, and self-efficacy likely play a role in this evolution.

Key Findings: The Impact of Father Absence

- **Significant Maths Penalties:** Sustained father absence is linked to substantially lower Maths scores for *both* boys and girls.
- **Different Pathways of Disadvantage:**
  - **For Boys:** The penalty involves both *lower skills* (endowments) and *lower returns* to their skills/background across development.
  - **For Girls:** The disadvantage at age 9 is mainly through *lower returns* and challenging interactions (e.g., with family resources). By age 13, it's a mix of skill differences and returns.
- **Contextual Factors Matter:** Maternal education and family resources appear particularly important in how father absence affects girls' outcomes.
- **Aligns with Existing Research:** Supports findings on boys' sensitivity to family instability and the role of parental investment for girls.

Main Takeaways & Policy Implications

- **Timing is Everything:** The nature of the Maths gender gap *changes* from childhood to adolescence.
  - Early (age 9) gaps are more about **differential returns** to skills.
  - Later (age 13) gaps are more about **actual skill differences**.
- **Intervene Early & Differently:**
  - Address how girls' early skills are valued/rewarded in Maths (childhood focus).
  - Support girls' numerical skill development leading into adolescence.
- **Father Absence Matters Profoundly (and Differently):**
  - Requires tailored support, considering distinct pathways for boys (skills & returns) and girls (resources & returns).
- **Overall Message:** Early interventions to ensure equitable treatment and skill development can prevent initial disparities from becoming entrenched educational inequalities.

Conclusion

Thank you so much.
Any questions or suggestions?
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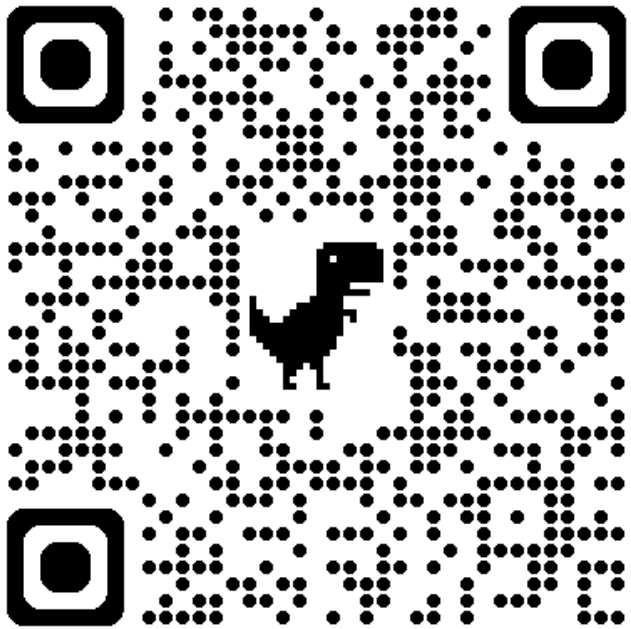

Leaving Certificate Grading Systems: Harmonised Points

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Old Grade	% Marks	New Grade (Post–2017)	New Code	Points (Higher)	Points (Ordinary
A1	90–100	H1	01	100	56
A2	85–90	H2	02	88	46
B1	75–80	H3	02	88	77
B2	70–75	H3	03	77	37
C1	65–60	H4	04	66	28
C2	55–60	H4	04	66	20
C3	55–60	H5	05	56	20
D1	50–55	H5	05	56	20
D2	45–60	H6	06	46	12
E	25–40	H7	H7	33	0
F	10–25	H8	H8	0	0

Summary Statistics – Key Highlights

- **Sample:** 4,333 students from the GUI '98 Cohort
- **Maths LC (Harmonized):** Mean = 56.03 (out of 100)
- **Grading Reform:** 39% sat the post-2017 Leaving Cert
- **Cognitive Skills:**
  - Assessed at ages 9 and 13 (logit scores and BAS Matrices)
  - Wide variation across verbal, numerical, and reasoning domains
- **Noncognitive Skills (SDQ):**
  - Emotional, Conduct, Hyperactivity, and Peer Problems (0–10 scale)
  - Hyperactivity scores highest on average
- **Parental Education:** 32–36% of caregivers have third-level education
- **Father Absence:**
  - 12% absent at age 9, 21% at age 13
  - 11% consistently absent across both waves
- **SES:** Mean income quintile = 3.5 (slightly skewed high)
- **School Types:**
  - 11% DEIS, 11% Fee-paying, 67% Religious
  - 53–76% attended mixed-gender schools (varies by wave)

Father Absence and Student Outcomes

- **Large achievement gap:** Students with absent fathers score nearly 16 points lower (harmonized scale) in Leaving Cert Maths.
- **Cognitive disadvantage:** Father-absent students show significantly lower cognitive scores at both ages 9 and 13 (e.g., a 5.4-point gap in Matrix Reasoning).
- **Worse behavioural outcomes:** Higher SDQ problem scores across all domains for father-absent students (especially hyperactivity and emotional symptoms).
- **Lower SES:** Father-absent households are concentrated in lower income quintiles and show lower parental education.
- **School differences:** Father-absent children are less likely to attend fee-paying or religious schools, and more likely to attend DEIS schools.
- **Gender imbalance:** Slightly higher proportion of boys among the father-absent group.