The Journey of Mathematically Gifted Students in Chile from Primary School to Higher Education

Economics of Talent Meeting - NBER

Amrita Ahuja, *Douglas B. Marshall, Jr. Family Foundation*
Fernanda Ramirez-Espinoza, *Pontificia Universidad Catolica de Chile*

November 15, 2024

Background

- **Global Evidence of Lost Talent**: Problematic for individuals as they forgo a lifetime of high earnings and from talent allocation inefficiencies from an economic-wide perspective (Hsieh et al., 2019).
- **Lack of Evidence for Developing World**: Evidence on high-performing students comes from the US and Europe although over 75% of school-age children live in developing countries (World Bank Group, 2024), where talent misallocation may be even higher (Ugarov, 2019).
- High-performing students from poor countries are less likely to participate in knowledge production (extensive m.) and to be less productive when they do (intensive m.) (Agarwal and Gaule, 2020).
- **This Paper**: We describe stylized trends, tracking the educational trajectory of high-performing math students in Chile, focusing on gender and income disparities in STEM outcomes.

Methodology

- **Panel Data**: Chilean Education Quality Measurement System (SIMCE) data from 2011 Grade 4 cohort, following students to higher education entrance in 2020.
- **Sample Size**: 240,897 students overall; focus on top 2.5% math scorers (5,000 students) to observe high-achieving students' trajectories.
- **Variables**: test scores, gender, income (measured by subsidy eligibility), and school socioeconomic status (SES).
- **Longitudinal Tracking**: From Grade 4 math scores to college enrollment.

Key Findings - All Students

	SD from Mean		Porcentage of Enrollment				
	Math 4th	Math 10th	Higher Edu	Uni	STEM	Top Uni	STEM Top Uni
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Gender							
Female	-0.038	-0.033	0.421	0.292	0.066	0.038	0.010
Male	0.037	0.035	0.389	0.244	0.212	0.032	0.016
Panel B: School Type							
Low Income	-0.462	-0.594	0.270	0.117	0.092	0.004	0.001
Middle-Low Income	-0.303	-0.434	0.322	0.152	0.111	0.009	0.002
Middle Income	0.002	-0.026	0.410	0.254	0.143	0.021	0.007
Middle-High Income	0.386	0.454	0.487	0.404	0.174	0.048	0.018
High Income	0.835	0.921	0.678	0.648	0.216	0.208	0.079
Panel C: Subsidy							
Subsidy	-0.259	-0.363	0.323	0.165	0.111	0.010	0.003
No Subsidy	0.153	0.182	0.453	0.329	0.157	0.050	0.019
Mean All Sample	-0.000	-0.000	0.405	0.268	0.140	0.035	0.013
Observations	214880	146283	214880	214880	214880	214880	214880

Key Findings - All Students

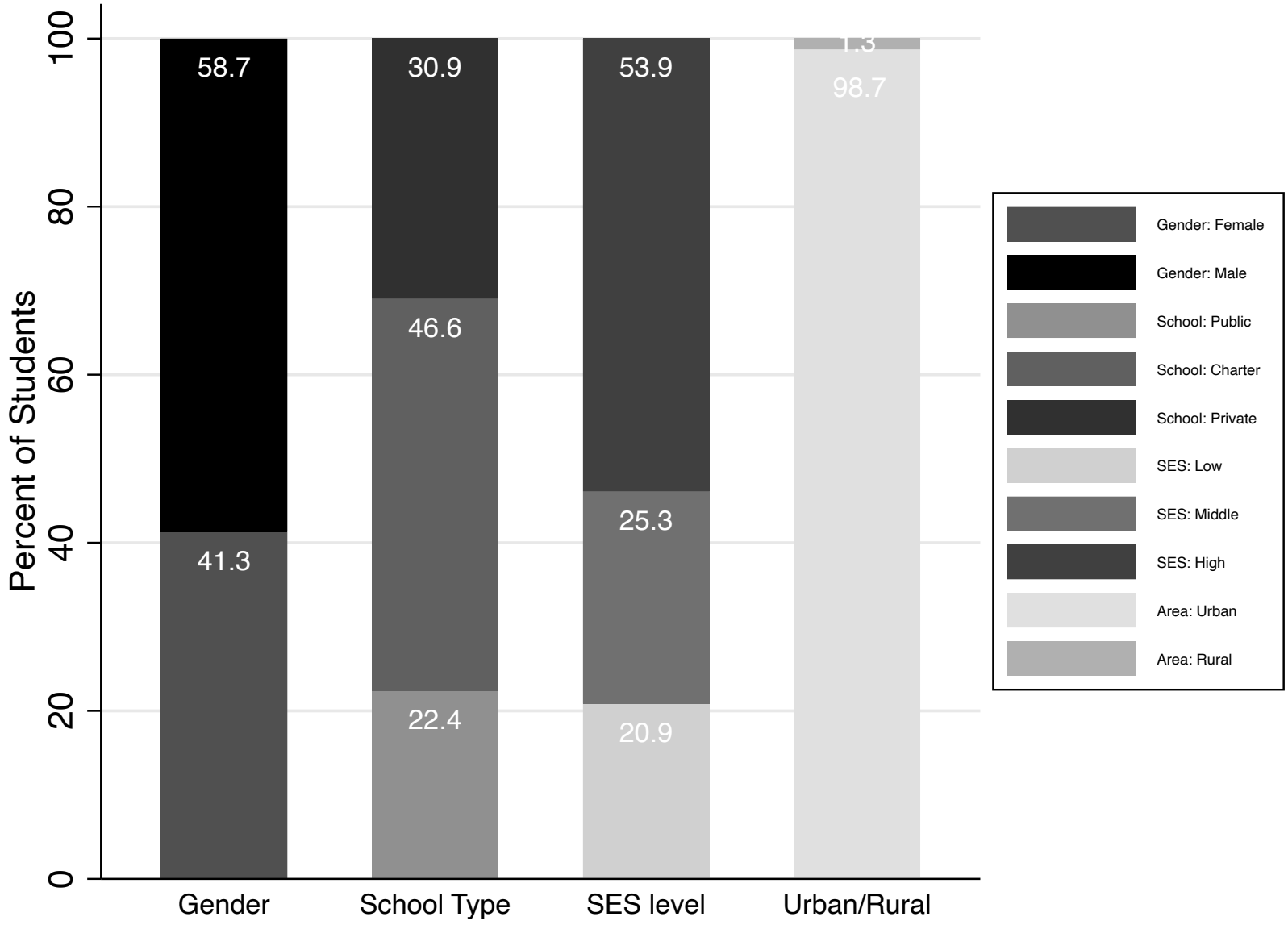
	SD from Mean			Porcentage of Enrollment			
	Math 4th	Math 10th	Higher Edu	Uni	STEM	Top Uni	STEM Top Uni
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Gender							
Female	-0.038	-0.033	0.421	0.292	0.066	0.038	0.010
Male	0.037	0.035	0.389	0.244	0.212	0.032	0.016
Panel B: School Type							
Low Income	-0.462	-0.594	0.270	0.117	0.092	0.004	0.001
Middle-Low Income	-0.303	-0.434	0.322	0.152	0.111	0.009	0.002
Middle Income	0.002	-0.026	0.410	0.254	0.143	0.021	0.007
Middle-High Income	0.386	0.454	0.487	0.404	0.174	0.048	0.018
High Income	0.835	0.921	0.678	0.648	0.216	0.208	0.079
Panel C: Subsidy							
Subsidy	-0.259	-0.363	0.323	0.165	0.111	0.010	0.003
No Subsidy	0.153	0.182	0.453	0.329	0.157	0.050	0.019
Mean All Sample	-0.000	-0.000	0.405	0.268	0.140	0.035	0.013
Observations	214880	146283	214880	214880	214880	214880	214880

Key Findings - All Students

	SD from Mean		Porcentage of Enrollment				
	Math 4th	Math 10th	Higher Edu	Uni	STEM	Top Uni	STEM Top Uni
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Gender							
Female	-0.038	-0.033	0.421	0.292	0.066	0.038	0.010
Male	0.037	0.035	0.389	0.244	0.212	0.032	0.016
Panel B: School Type							
Low Income	-0.462	-0.594	0.270	0.117	0.092	0.004	0.001
Middle-Low Income	-0.303	-0.434	0.322	0.152	0.111	0.009	0.002
Middle Income	0.002	-0.026	0.410	0.254	0.143	0.021	0.007
Middle-High Income	0.386	0.454	0.487	0.404	0.174	0.048	0.018
High Income	0.835	0.921	0.678	0.648	0.216	0.208	0.079
Panel C: Subsidy							
Subsidy	-0.259	-0.363	0.323	0.165	0.111	0.010	0.003
No Subsidy	0.153	0.182	0.453	0.329	0.157	0.050	0.019
Mean All Sample	-0.000	-0.000	0.405	0.268	0.140	0.035	0.013
Observations	214880	146283	214880	214880	214880	214880	214880

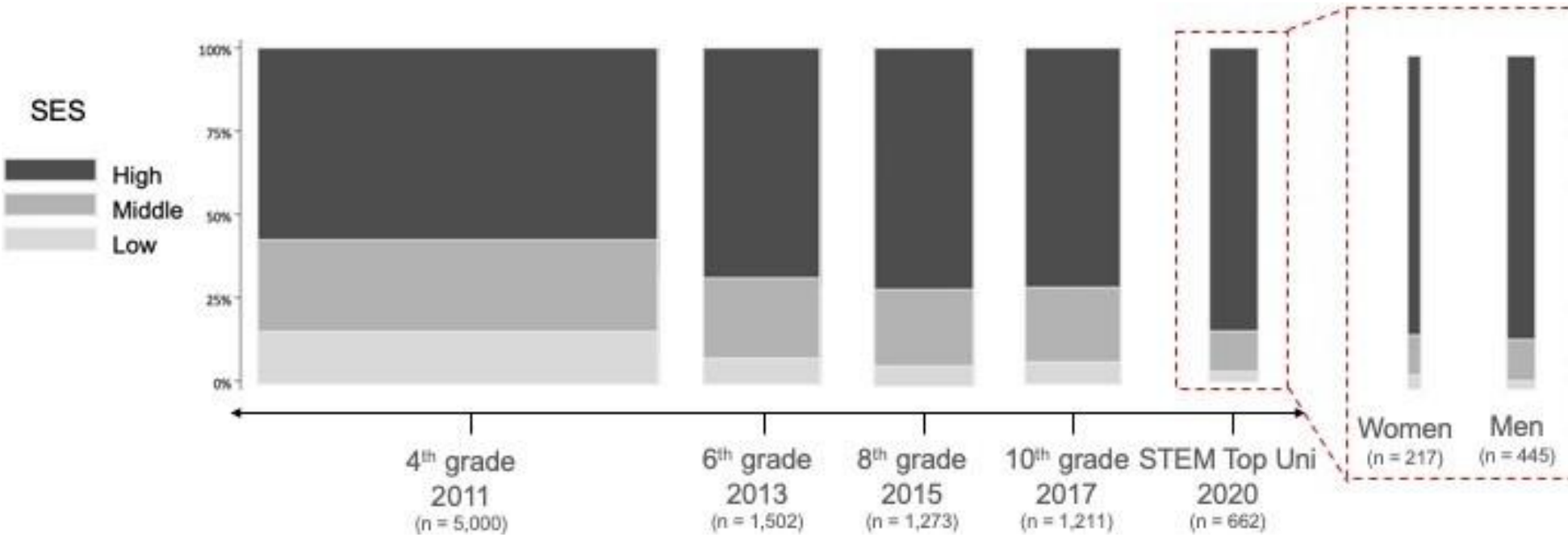
Key Findings - Top Math Talent

Sample: top-5000 students in the 4th grade (top 2.5% of the distribution)



Key Findings - Top Math Talent

Sample: top-5000 students in the 4th grade (top 2.5% of the distribution)



Key Findings - Top Math Talent

To explore the relationship between SES and Higher Education/Outcomes, we estimate the following model for Top-math scoring students:

$$Y_i = \beta_0 + \beta_1 MathScore_i + \beta_2 Male + \beta_3 Subsidy$$

	(1) Higher Educ	(2) Any uni	(3) STEM uni	(4) Top Uni	(5) Top Uni
Math Score (SD)	0.114***	0.133***	0.076*	0.151***	0.091***
	(0.035)	(0.036)	(0.035)	(0.032)	(0.025)
Male	0.0116	-0.0184	0.186***	-0.0197	0.045***
	(0.013)	(0.013)	(0.013)	(0.012)	(0.009)
Student Subsidy	-0.080***	-0.138***	-0.125***	-0.184***	-0.112***
	(0.017)	(0.017)	(0.017)	(0.016)	(0.012)
Constant	0.477***	0.411***	0.053	-0.054	-0.087
	(0.077)	(0.080)	(0.077)	(0.071)	(0.055)
Observations	5000	5000	5000	5000	5000

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Alternative SES measure estimations

Higher Education and STEM Enrollment

- **Predictive Value of Early Math Talent**: Students scoring in the top 2.5% in Grade 4 math are 10.9 times more likely to stay in the top 2.5% by Grade 10.

	(1)	(2)
	Top 2.5-10th	STEM enrollment
2.5-4th grade	0.238***	0.225***
	(0.003)	(0.004)
Constant	0.025***	0.081***
	(0.000)	(0.001)
Observations	146283	214880

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Higher Education and STEM Enrollment

- **Predictive Value of Early Math Talent**:
  - Students scoring in the top 2.5% in Grade 4 math are 10.9 times as likely to be in the top 2.5% by Grade 10 as the bottom 97.5%.
  - These students are 22.6 percentage points more likely to enroll in STEM programs.
- **Gender Gap in STEM**: Despite comparable talent, girls are 18.5 percentage points less likely than boys to enroll in STEM programs at the university level.
- **Income-Based Differences**: Non-subsidized students are 8 percentage points more likely to pursue higher education and 11.2 percentage points more likely to pursue STEM at elite universities.
- **School SES Correlation**: Students in high SES schools are 1.4 times more likely to attend university, 2.7 times more likely to pursue STEM, and 15.6 times more likely to pursue STEM at elite programs.

Discussion - Possible Causes of Disparities

- **Parental Expectations and Student Aspirations**: Lower expectations for low-income students impact their academic trajectory (Beaman et al., 2012; Eble & Hu, 2022).

	(1) Parent Exp.	(2) Parent Exp.	(3) Parent Exp.	(4) Parent Exp.
Math Score 4th (SD)	0.0621***	0.0618***	0.0871***	0.0615***
	(0.001)	(0.001)	(0.001)	(0.001)
Student Subsidy	-0.120***	-0.113***	-0.116***	-0.121***
	(0.008)	(0.009)	(0.007)	(0.007)
Student Subsidy × Math Score 4th (SD)		0.0123	-0.00924	0.0130*
		(0.008)	(0.006)	(0.006)
Percentage Subsidy School			-1.035***	
			(0.024)	
Middle-Low				0.0925***
				(0.003)
Middle				0.196***
				(0.003)
Middle-High				0.294***
				(0.004)
High				0.310***
				(0.004)
Constant	0.804***	0.804***	0.826***	0.634***
	(0.000)	(0.000)	(0.001)	(0.003)
Observations	191276	191276	191276	191276

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Discussion - Possible Causes of Disparities

- **Parental Expectations and Student Aspirations**: Lower expectations for low-income students impact their academic trajectory (Beaman et al., 2012; Eble & Hu, 2022).
- **Financial Aid Knowledge**: Many low-income families lack information on navigating college preparation and financial aid systems (Barrios-Fernandez, Eluchans & Ramirez-Espinoza, 2024)
- **Quality of Instruction**: Differences in teaching quality and resources available at low-SES schools may hinder student outcomes.

Conclusion

- Early grades are often predictive of later success. However, most talented students identified in Grade 4 do not ultimately enroll in STEM fields in higher education.
- There are stark differences in the extensive margin to which talent is developed, including by gender and SES. For instance:
  - Gender: girls go to university, but much more unlikely to do STEM
  - SES: impacts both university attendance and STEM
- SES differences in STEM are not only from individual poverty, but from schools that have a concentration of low SES students
- Early math talent predicts academic success, but disparities by gender and income limit opportunities.
- The talent of mathematically gifted students from disadvantaged backgrounds is getting lost in developing countries – more evidence is needed on the effects of this drop-off and what can be done to keep them on the STEM track.

Q&A

Thank you!

Any questions?

fernanda.ramirez@uc.cl

www.ramirezespinoza.com

Key Findings - Top Math Talent

	(1) Higher Ed	(2) Higher Ed	(3) Any uni	(4) Any uni	(5) STEM uni	(6) STEM uni	(7) Top Uni	(8) Top Uni	(9) Top STEM Uni	(10) Top STEM Uni
Math Score (SD)	0.115***	0.104**	0.134***	0.118***	0.0773*	0.0725*	0.152***	0.122***	0.0920***	0.0771**
	(0.035)	(0.034)	(0.036)	(0.036)	(0.035)	(0.035)	(0.032)	(0.030)	(0.025)	(0.024)
Male	0.0118	0.0138	-0.0183	-0.0150	0.185***	0.187***	-0.0199	-0.0136	0.0445***	0.0478***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.011)	(0.009)	(0.009)
Student Subsidy	-0.0808***	-0.0207	-0.139***	-0.0332	-0.125***	-0.0553**	-0.184***	-0.0391*	-0.112***	-0.0313*
	(0.017)	(0.019)	(0.017)	(0.020)	(0.017)	(0.019)	(0.016)	(0.017)	(0.012)	(0.014)
Middle-Low income		0.0584		0.0858*		0.0933*		0.0223		0.00373
		(0.042)		(0.044)		(0.042)		(0.037)		(0.029)
Middle income		0.0846*		0.132**		0.135***		0.0762*		0.0273
		(0.041)		(0.042)		(0.041)		(0.036)		(0.029)
Middle-High income		0.0928*		0.184***		0.201***		0.110**		0.0725*
		(0.042)		(0.043)		(0.042)		(0.037)		(0.029)
High income		0.201***		0.317***		0.215***		0.388***		0.194***
		(0.042)		(0.043)		(0.042)		(0.037)		(0.029)
Constant	0.474***	0.372***	0.408***	0.232**	0.0506	-0.119	-0.0566	-0.188*	-0.0897	-0.159**
	(0.077)	(0.086)	(0.080)	(0.089)	(0.077)	(0.086)	(0.071)	(0.076)	(0.055)	(0.060)
Observations	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

Back