

Starting Together, Diverging Later? Gender Differences in Universal Pre-K's Long-Term Effects

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Motivation

- Public Universal pre-K (UPK) is expanding, but most evidence of its benefits comes from:
 - Intensive mean-tested interventions (e.g. Perry Preschool, Head Start)
 - Short term outcomes standardized tests where fade out has been repeatedly observed
- Evidence on the long-term consequences of UPK is scarce and findings are mixed
- Majority of long term studies estimate an intention to treat parameter (ITT)



Motivation

- Why ITT? Because individual-level data linking pre-K enrollment decisions to long-term outcomes are rarely available
- Limitations of ITT:
 - TEs are recovered using a Wald estimator ($TE = \frac{ITT}{take-up}$), making inference challenging
 - Heterogeneity in ITT may reflect heterogeneity in TE or in take-up, since $ITT = TE \times take-up$
 - ITT captures both direct effects on participants and spillover effects on non-participants
- These limitations all stem from the absence of detailed data on pre-K enrollment.

This Paper

- Link administrative data on age three UPK enrollment and long run educational achievements
- Estimate the **treatment** effect of attending UPK at age 3 on school progression and high school outcomes
- Use a sibling fixed effects design to identify the causal effect
- Focus on expansion of UPK in Arab municipalities in Israel during 2000-2005 that generated within household variation in pre-K attendance
- Test potential mechanisms for the observed sex differences in returns to UPK

Contribution I: Long Run Consequences of UPK

- I obtain precise treatment estimates of the long term effect of *attending* UPK
- Long term *treatment* effect of preschool
 - Lotteries: Gray-Lobe et al. (2022)
 - Sibling FE (Head Start): Currie & Thomas (1995), Garces et al. (2002), Deming (2009)
- Long term effect of *access* to UPK
 - Norway: Havnes & Mogstad (2011), Black et al. (2014), Havnes & Mogstad (2015)
 - Canada: Baker et al. (2008), Kottelenberg & Lehrer (2017), Baker et al. (2019)
 - Israel: DeMalach & Schlosser (2024)
 - US: Gormley & Gayer (2005), Fitzpatrick (2008), Barr et al. (2024)

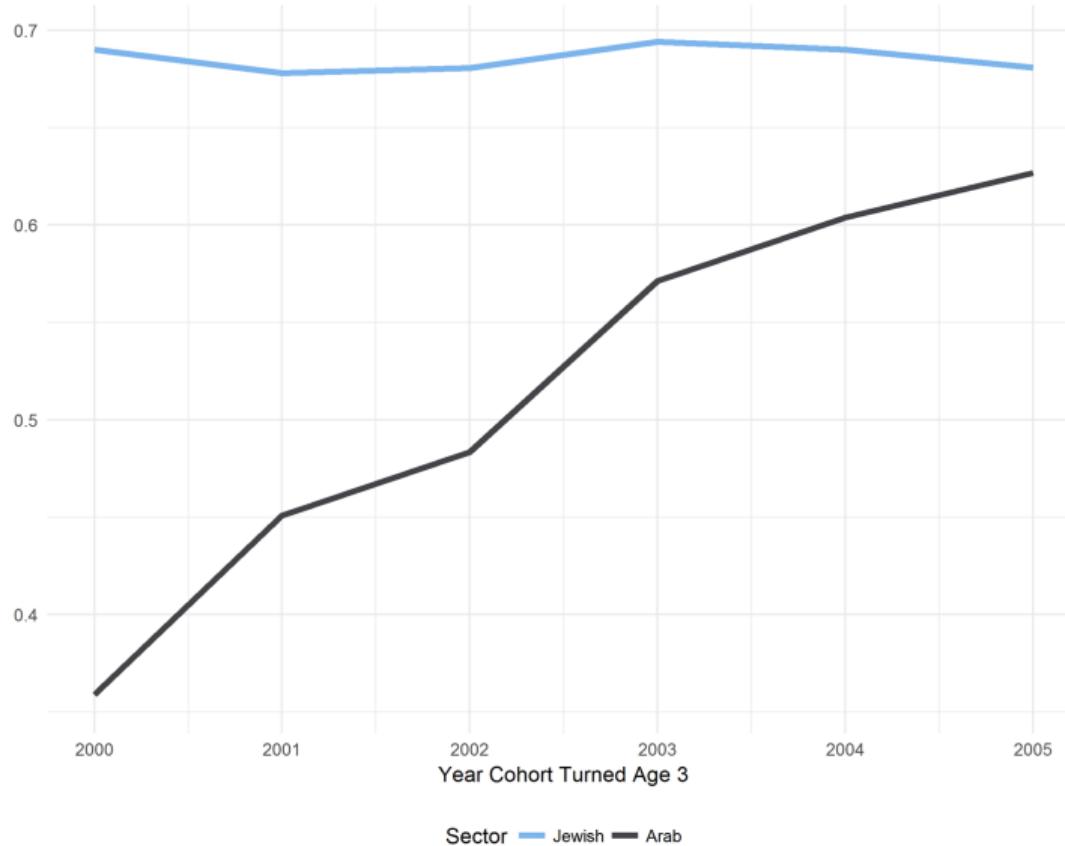
Contribution II: Mechanisms and Heterogeneity of UPK

- I test potential explanations for gender differences in returns to early childhood interventions
- Biological Differences: Boys develop more slowly and less ready to benefit from UPK
 - Differential school readiness across sexes: Reeves (2022); Magnuson et al. (2016); Deming & Dynarski (2008); Cook & Kang (2020)
 - Differential response to early education investments: Fidjeland et al. (2023); Ewing & Taylor (2009); Rose & Rudolph (2006)
- Cultural Differences: Girls suffer from worse counterfactual home environment
 - Intra-household investments favor boys in developing countries: Barcellos et al. (2014); Jayachandran & Pande (2017)
 - Girls are less likely to play outdoors and more likely to participate in household chores: UNDP (2006); Feki et al. (2017)

Background: Pre-K in Israel

- Public Pre-K in Israel
 - Starts at age 3
 - Run by municipalities
 - Regulated by the government
 - Full day
- Before 2000 Many Arab-majority municipalities underprovided pre-K services
- Starting 2000, a national rollout of UPK began, starting with the poorest localities
- I focus on Arab-majority towns that experienced an expansion from 2000 to 2005

Pre-K Enrollment



Background: Arab Citizens of Israel

- Constitute approximately 20% of Israel's population; the majority are Muslim
- Characterized by patriarchal gender norms
- Women's labor force participation is growing but remains markedly low
- Gendered expectations emerge early in childhood
- In the absence of public pre-K, mothers typically assume childcare responsibilities

Data and Sample

- Data (2000-2019):
 - Background information (parent ID, parent education, sex, DOB)
 - Enrollment in Pre-K
 - School progression (grade repetition, dropout)
 - High school achievements (*Bagrut* diploma, diploma quality)
- Sample restrictions:
 - 33 Arab-majority towns included in the second stage of the expansion
 - Children turned 3 in 2000-2005
 - 55,645 students (~ 30% of Arab students) [summary stats](#)

Selection

	Dependent variable: Pre-K Enrollment			
	Univariate (1)	Multivariate Models		
	(2)	(3)	(4)	
Girl	-0.001 (0.003)	0.001 (0.003)	-0.001 (0.003)	0.004 (0.004)
Father Schooling > 10	0.014*** (0.003)	0.009*** (0.003)	0.019*** (0.004)	-
Mother Schooling > 10	0.118*** (0.003)	0.068*** (0.004)	0.029*** (0.008)	-
Family Size	-0.033*** (0.001)	-0.039*** (0.003)	-0.003 (0.003)	-
Month of Birth	-0.007*** (0.0005)	-0.007*** (0.0005)	-0.007*** (0.001)	-0.007*** (0.001)
Birth Order	-0.025*** (0.001)	0.024*** (0.002)	-0.004 (0.003)	0.003 (0.003)
Municipality-Cohort Fixed Effects	x	x	✓	✓
Family Fixed Effects	x	x	x	✓
Observations	54,264	54,264	54,264	40,669

OLS

Empirical Strategy

- I estimate the following fixed effects model

$$y_i = \alpha + \beta PreK_i + \gamma X_i + \delta_{j(i)} + \theta_{k(i)t(i)} + \epsilon_i \quad (1)$$

- y_i - child i 's educational outcome
- $PreK_i$ - indicator for age 3 pre-K enrollment
- X_i - vector of child's background characteristics (including birth order)
- $\delta_{j(i)}$ - family fixed effect
- $\theta_{k(i)t(i)}$ - cohort-town fixed effect
- Identifying assumption: within family variation in pre-K attendance is uncorrelated with unobservables

Who Are the Families Who Switch?

- Only families with variation in pre-K (*switchers*) identify β (Miller et al. 2023)
- I define four types of families:
 1. Never Takers - send none of their children to pre-K
 2. Always Takers - send all of their children to pre-K
 3. Expansion Compliers - send the youngest child to pre-K and not the oldest child
 4. Expansion Defiers - send the oldest child to pre-K and not the youngest child

Who Are the Families Who Switch?

	Non-switchers		Switchers	
	Never Takers (1)	Always Takers (2)	Expansion Compliers (3)	Expansion Defiers (4)
Number of Families	1,430	11,982	2,608	727
Children in Sample per Family	2.58	2.37	2.63	2.47
Father Years of Schooling	9.87	10.44	9.92	10.08
Mother Years of Schooling	9.09	10.37	9.53	9.61
Young Child Born Sep-Dec (%)	44.8%	38.8%	35.3%	50.6%
Birth Order	3.99	2.83	3.69	3.50
Family Size	4.82	3.49	4.45	4.19
Oldest Child Attended				
Pre-K at Age 3	0	1	0	1
Pre-K at Age 4	0.40	0.97	0.73	0.85

- About 80% of switchers are expansion compliers
→ This is not the case in non-expansion towns results
- Expansion defiers are more likely to have younger child born Sep-Dec

Results - Effect on School Progression

	First Grade on time	Grade Repeat	11 th Grade	Grad HS on Time	Grad HS
Estimate	0.019*** (0.004)	-0.013* (0.007)	0.009 (0.007)	0.024** (0.008)	0.008 (0.007)
Mean	0.979	0.108	0.879	0.820	0.852
Observations	40,644	40,644	40,644	40,644	40,644
Adjusted <i>R</i> ²	0.077	0.237	0.293	0.305	0.309

Results - HS Diploma Outcomes

	HS Diploma (Bagrut)	Diploma Credits	Advanced Math	Advanced English	Advanced Hebrew
Estimate	0.003 (0.009)	0.442** (0.215)	-0.007 (0.007)	0.012 (0.009)	0.010 (0.008)
Mean	0.527	19.403	0.213	0.466	0.312
Observations	40,644	40,644	40,644	40,644	40,644
Adjusted R^2	0.396	0.549	0.436	0.476	0.439

Heterogeneity - Sex

	First Grade On Time	Grade Repeat	11 th Grade	Grad HS on Time	Grad HS
Boys	0.016*** (0.005)	-0.007 (0.009)	-0.017* (0.009)	0.006 (0.011)	-0.014 (0.010)
Girls	0.022*** (0.004)	-0.018** (0.008)	0.036*** (0.008)	0.042*** (0.009)	0.030*** (0.009)
p-value for equal effects	0.240	0.240	0.000	0.002	0.000
Joint p-value across outcomes			6.03e-10		

Who Benefits More from UPK?

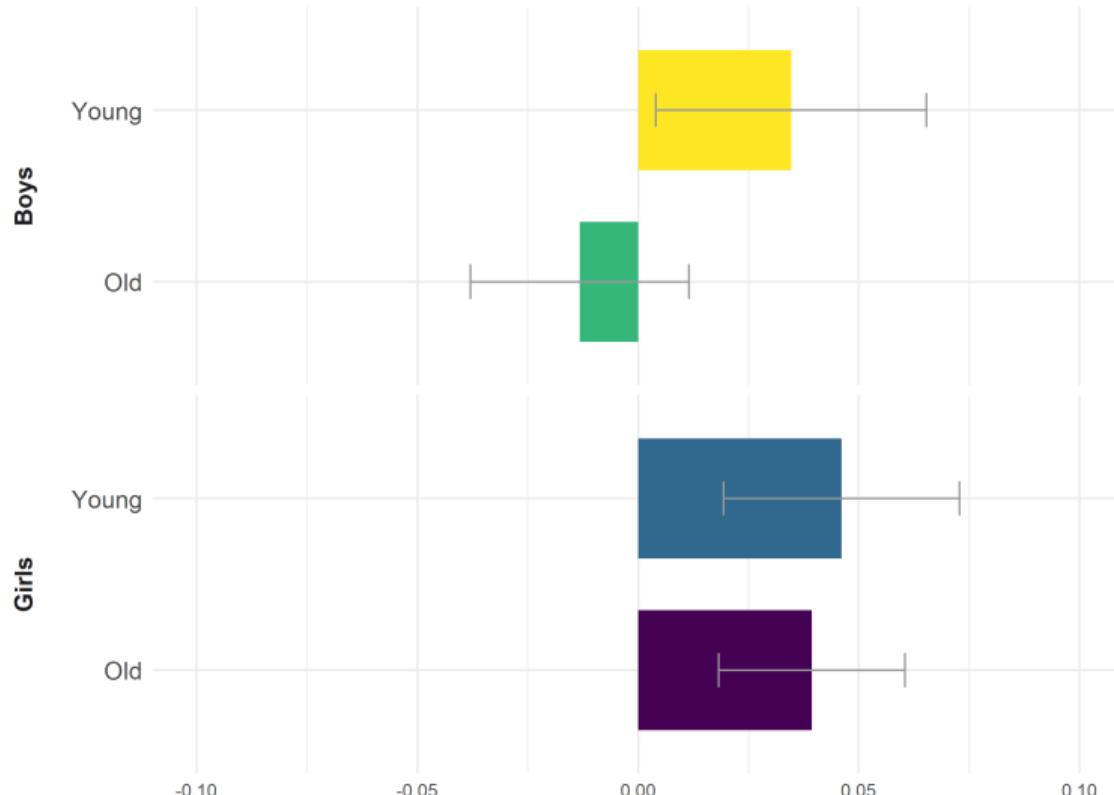
- **Strong heterogeneity by sex:** Girls benefit substantially more from UPK.
- **Relative age:** Younger children benefit more than older ones. [results](#)
 - Reverse selection on gains.
- **Mother's education:** Children of more-educated mothers benefit more. [results](#)
 - Explained by both boys and girls benefit in high-education families, while in low-education families **only girls** benefit.
- **Family size:** Children from larger families show modestly larger gains. [results](#)

What Can Explain Sex Heterogeneity?

- **Differences in development**
 - Girls start UPK when they are more developmentally ready to benefit from it
 - Prediction: older boys should gain more from UPK than younger boys
- Differences in home environment
 - Parents invest more in boys than girls
 - Gender norms in traditional societies cause girls and boys to engage in different activities

Heterogeneity by Sex and Relative Age

The Effect of Attending UPK on Graduating HS on time

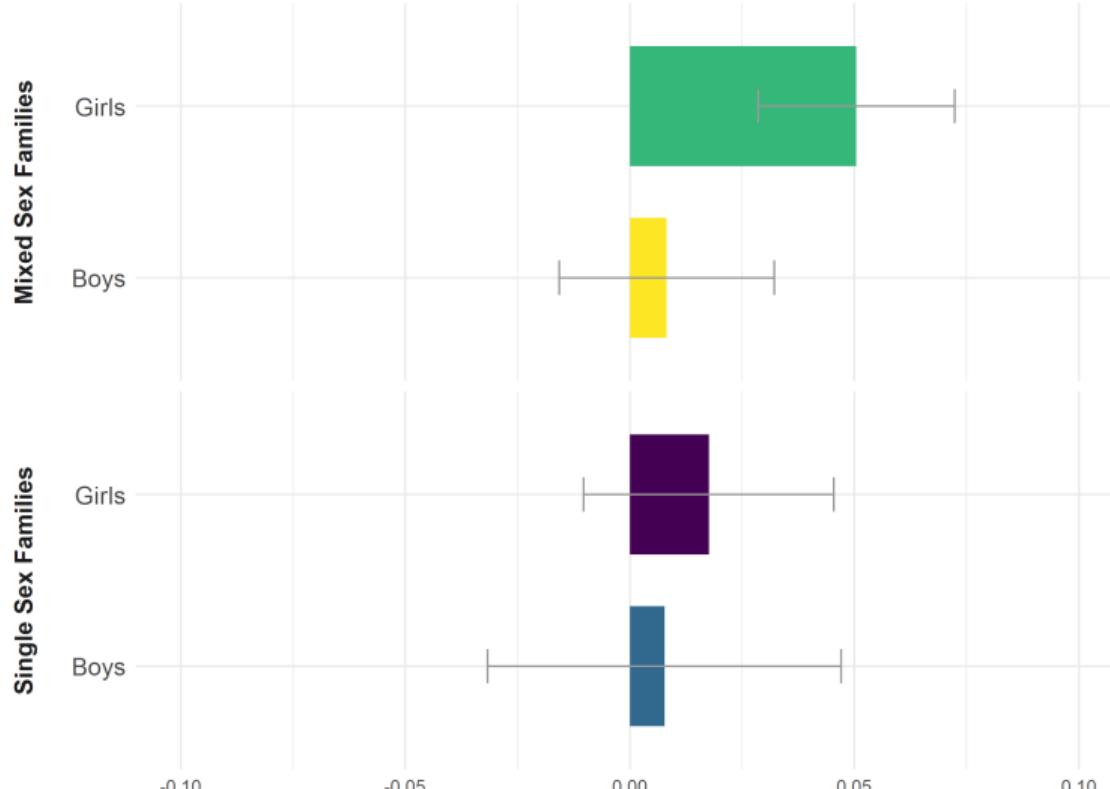


What Can Explain Sex Heterogeneity?

- Differences in development
 - Girls start UPK when they are more developmentally ready to benefit from it
- **Differences in home environment**
 - Parents invest more in boys than girls
 - Prediction: treatment effects are expected to show greater sex heterogeneity among children from mixed-sex sibling families
 - Gender norms in traditional societies cause girls and boys to engage in different activities

Heterogeneity by Sex and Household Composition

The Effect of Attending UPK on Graduating HS on time

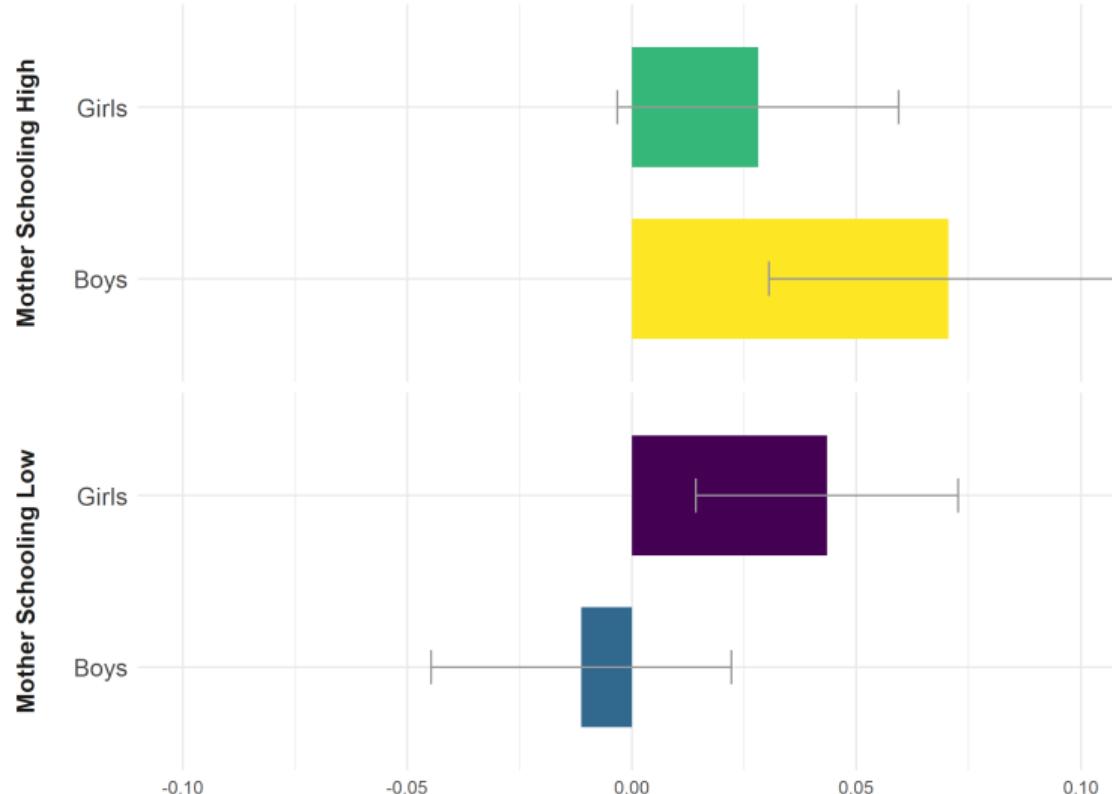


What Can Explain Sex Heterogeneity?

- Differences in development
 - Girls start UPK when they are more developmentally ready to benefit from it
- **Differences in home environment**
 - Parents invest more in boys than girls
 - Gender norms cause girls and boys to engage in different activities at home
 - Prediction: heterogeneity should be stronger in more traditional families (proxied by mother education)

Heterogeneity by Sex and Maternal Schooling

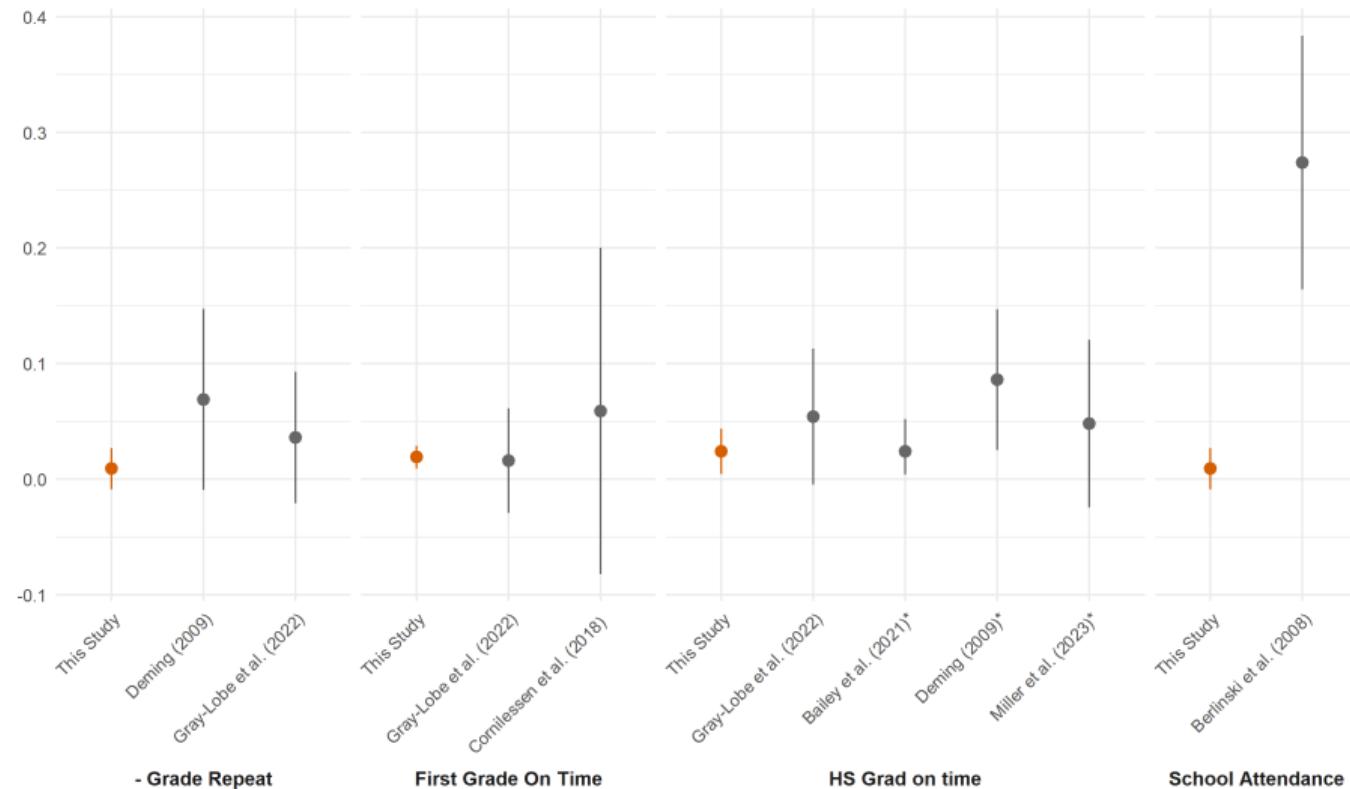
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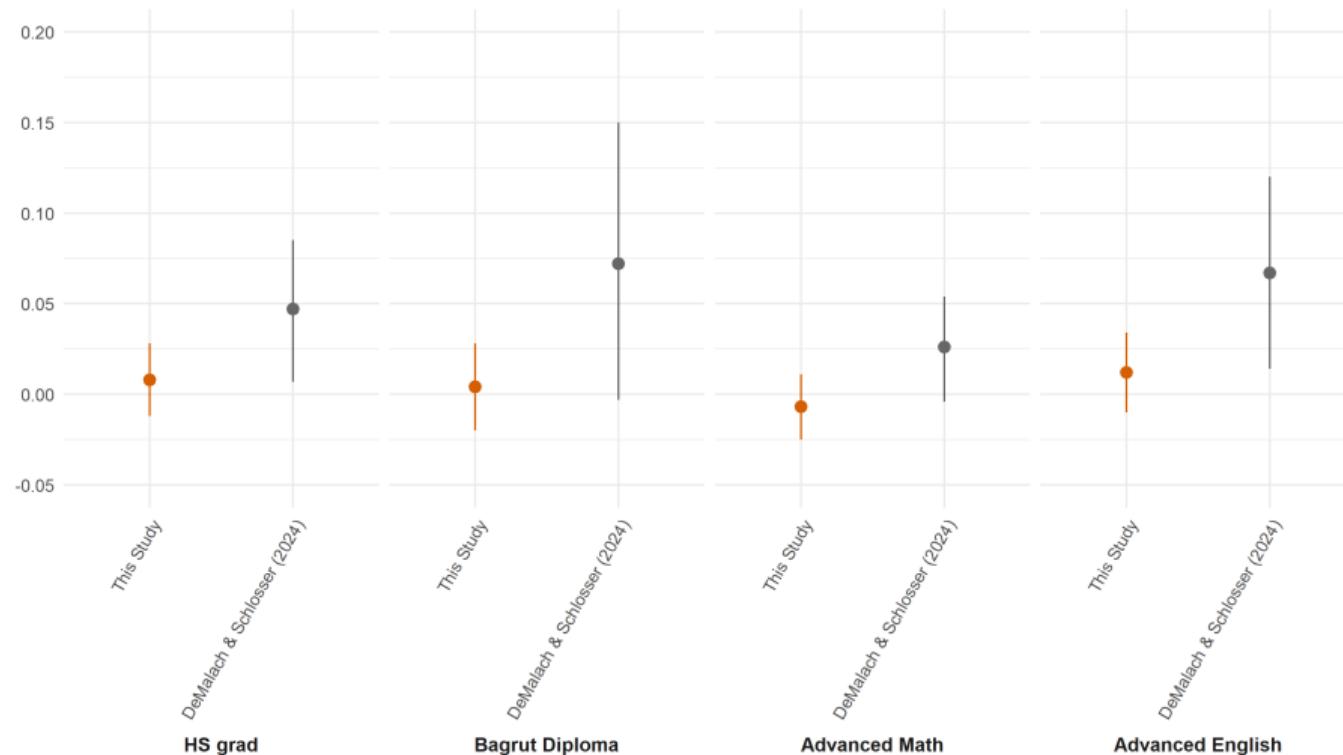
Additional Results and Robustness

- Additional Results
 - No heterogeneity in educational achievements outcomes results
 - No evidence for spillover to siblings results
- Robustness
 - Excluding expansion defiers robustness
 - Specifications (no controls of mob; common cohort FEs) robustness
 - Sample of towns all

Effect Size - Comparison to Literature



Effect Size - Comparison to Literature (DeMalach & Schlosser 2024)



Conclusions

- I obtain precise long-term *treatment effects* of universal public pre-K
- Pre-K improves school progression, although the effects are smaller than in previous studies
- Girls benefit more than boys from UPK
- This gender gap arises because pre-K compensates for unequal home environments
- Pre-K equalizes early childhood environments but enhances sex disparities in educational outcomes in adolescence

Expansion Compliers by MOB

Expansion Towns

Younger Sibling	Older Sibling	
	Jan-Aug	Sep-Dec
Jan-Aug	80.0%	87.4%
Sep-Dec	68.5%	76.9%

Non-Expansion Towns

Younger Sibling	Older Sibling	
	Jan-Aug	Sep-Dec
Jan-Aug	50.2%	56.6%
Sep-Dec	44.3%	54.4%

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Heterogeneity - Relative Age

	First Grade On Time	Grade Repeat	11 th Grade	Grad HS on Time	Grad HS
Young	0.026*** (0.006)	-0.018* (0.009)	0.016* (0.009)	0.040*** (0.011)	0.011 (0.010)
Old	0.014*** (0.004)	-0.009 (0.009)	0.005 (0.008)	0.013 (0.011)	0.005 (0.009)
p-value for equal effects	0.043	0.369	0.263	0.026	0.628
Joint p-value across outcomes			0.0448		

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Heterogeneity - Mother Education

	First Grade On Time	Grade Repeat	11 th Grade	Grad HS on Time	Grad HS
High	0.039*** (0.007)	-0.021* (0.012)	0.016 (0.011)	0.050*** (0.014)	0.024** (0.012)
Low	0.014** (0.005)	-0.017 (0.011)	0.015 (0.011)	0.016 (0.012)	0.001 (0.011)
p-value for equal effects	0.003	0.810	0.978	0.057	0.131
Joint p-value across outcomes			0.0121		

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Heterogeneity - Family Size

	First Grade On Time	Grade Repeat	11 th Grade	Grad HS on Time	Grad HS
Small	0.016*** (0.005)	-0.008 (0.009)	-0.011 (0.009)	0.020* (0.011)	0.003 (0.010)
Large	0.021*** (0.005)	-0.016* (0.009)	0.023*** (0.009)	0.027*** (0.009)	0.011 (0.009)
p-value for equal effects	0.401	0.472	0.003	0.595	0.503
Joint p-value across outcomes			0.0516		

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Heterogeneity in HS Diploma Outcomes

	HS Diploma (Bagrut)	Diploma Credits	Advanced Math	Advanced English	Advanced Hebrew
Boys	0.002 (0.015)	0.619* (0.340)	-0.001 (0.012)	0.013 (0.014)	0.003 (0.014)
Girls	0.006 (0.015)	0.357 (0.353)	-0.012 (0.010)	0.011 (0.013)	0.019 (0.013)

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Summary Stats

Statistic	Entire Sample	Family FE Sample
Attended Pre-K	0.815 (0.388)	0.806 (0.395)
Girl	0.489 (0.500)	0.499 (0.500)
Father Schooling	10.296 (2.778)	10.241 (2.723)
Mother Schooling	10.092 (2.611)	10.008 (2.555)
Family Size	3.784 (1.954)	3.915 (1.973)
Month of Birth	6.621 (3.418)	6.626 (3.423)
Birth Order	3.144 (2.001)	3.161 (1.995)
First Grade on Time	0.980 (0.141)	0.979 (0.143)
Graduated High School on Time	0.826 (0.379)	0.820 (0.385)
Graduated High School	0.858 (0.349)	0.852 (0.355)
Attended 11th Grade	0.884 (0.321)	0.879 (0.326)
Ever Repeated a Grade	0.106 (0.308)	0.108 (0.326)
Diploma (Bagrut)	0.540 (0.498)	0.527 (0.499)
Diploma Credits	19.745 (12.840)	19.403 (12.872)
Advanced Math	0.223 (0.417)	0.213 (0.409)
Advanced English	0.483 (0.500)	0.466 (0.499)
Advanced Hebrew	0.316 (0.465)	0.312 (0.463)
Number of Students	54,264	40,644
Number of Families	30,466	16,747

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OLS Estimates

Dependent Variable: High School Diploma (Bagrut)					
	(1)	(2)	(3)	(4)	(5)
PreK-3	0.124*** (0.006)	0.089*** (0.007)	0.056*** (0.006)	0.050*** (0.007)	0.004 (0.012)
Background Controls	x	✓	✓	✓	✓
Municipality-Cohort FE	x	x	✓	✓	✓
Siblings Sample	x	x	x	✓	✓
Family FE	x	x	x	x	✓
Observations	54,264	54,264	54,264	40,644	40,644
Adjusted R ²	0.009	0.058	0.195	0.194	0.396

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Siblings Spillovers

Panel A: Heterogeneity by Sibling Spacing		
	(1)	(2)
PreK	0.023 (0.008)	0.024 (0.015)
PreK × Age Gap	0.007 (0.009)	-
PreK × 1{Age Gap > Median}	-	-0.005 (0.019)
Number of students	34,182	34,182
Number of families	16,747	16,747
Panel B: Difference-in-Differences		
	Main Sample (1)	All Arab-majority Towns (2)
Child 2 × Treated	0.001 (0.020)	-0.007 (0.008)
Number of students	8,966	29,916
Number of families	4,483	14,966

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Robustness

Robustness Test	HS Grad On Time	HS Diploma (Bagrut)
No Expansion Defiers	0.020** (0.009)	-0.005 (0.011)
Number of Observations	38,846	
Common Cohort Fixed Effect	0.025*** (0.007)	-0.005 (0.009)
Number of Observations	40,644	
No Control for Month of Birth	0.028*** (0.008)	0.006 (0.009)
Number of Observations	40,644	
All Arab-majority Municipalities	0.015*** (0.004)	0.001 (0.005)
Number of Observations	133,751	
Only Youngest and Oldest Child	0.023** (0.009)	0.005 (0.011)
Number of Observations	34,182	

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All Arabs Towns

	Panel A: School-Progression Outcomes				
	First Grade on time (1)	Grade Repeat (2)	11th Grade (3)	Grad HS on Time (4)	Grad HS (5)
Estimate	0.006*** (0.002)	-0.002 (0.004)	0.005 (0.004)	0.015*** (0.004)	0.009** (0.004)
Mean	0.978	0.107	0.845	0.782	0.813
Observations	133,751	133,751	133,751	133,751	133,751
Number of Families	55,138	55,138	55,138	55,138	55,138
Adjusted R ²	0.109	0.217	0.315	0.334	0.336

	Panel B: HS Diploma Outcomes				
	HS Diploma (Bagrut) (1)	Diploma Credits (2)	Advanced Math (3)	Advanced English (4)	Advanced Hebrew (5)
Estimate	-0.001 (0.005)	0.179 (0.111)	-0.003 (0.004)	0.004 (0.004)	0.001 (0.004)
Mean	0.437	16.214	0.172	0.387	0.250
Observations	133,751	133,751	133,751	133,751	133,751
Number of Families	55,138	55,138	55,138	55,138	55,138
Adjusted R ²	0.466	0.614	0.442	0.514	0.447

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