The Effects of More Informative Grading in Early Schooling: Evidence from Sweden

M. Collins[1] J. Lundstedt[1]

[1]Department of Economics
Lund University

Scandinavian PhD Student Seminar Series, 19 May 2020

Table of Contents

Background & Motivation

Motivation

- Driving efficiencies in inputs to the education production function is a pillar of education policy - grading feedback is one such input
- Education production is increasing in student motivation and effort
- Can the framing of grading feedback be leveraged to improve student outcomes?

This Paper

- Using register data, we examine the effect of receiving finer grades in early schooling
- Exploiting a nationwide reform to the grading scale in Swedish compulsory schools, we use a difference-in-discontinuity design to identify the effects of this reform on long-term educational outcomes
- We supplement this approach with data from other sources to identify the mechanisms through which these effects occur
- Using a surrogate index, we estimate the long-term effect on earnings

Results Preview

We find evidence of negative medium and long-term consequences of receiving finer grades.

- At high school-level, the likelihood of completing an academic track, a STEM track or completing high school at all fell by by 2-3 p.p.
- At university-level, boys are ca. 2 p.p. less likely to enroll in a STEM track
- We estimate a reduction in average earnings between ages 28-30 of ca. 1.15%
- We identify confidence in one's academic ability and mental health as mechanisms through which these effects occur

Literature and Contribution

Previous Literature

- Literature on extensive margin of receiving grading feedback
  - Bandiera, et al. (2015), Fischer & Sliwka (2018), Möbius, et al. (2014)
- Literature on relative grading feedback in education
  - Azmat & Iriberri (2010), Azmat, et al. (2018), Fischer & Wagner (2017), Goulas & Megalokonomou (2015), Tran & Zeckhauser (2012)

Previous Literature

- Most similar to us:
  - Jalava, et al. (2015)
  - Experiment randomising students into grading scales prior to a math test
  - Positive but insignificant effect of A-F grades, relative to continuous score
- Our Contribution:
  - First to use register data to examine finer grading
  - First to look at non-immediate outcomes of finer grading

Data & Institutional Context

The Swedish school system

- The Swedish school system:
  - 1st-9th grade in compulsory school, followed by 10th-12th grade in high school.
  - Students start first grade in Autumn of the year they turn 7.
- Students born in 1996 and earlier received grades from 8th grade onwards on a scale with three passing grades: godkänt (pass), väl godkänt ($\sim$ pass with distinction) and mycket väl godkänt ($\sim$ pass with special distinction).
- In 2011 a reform was passed which led to the introduction of a new grading scale, which was then implemented in 2012. This meant that students born in 1997 or later received grades on a scale with 5 passing grades (A/B/C/D/E).

The Reform

The change in scale was part of a larger reform:

- In 2011, a new curriculum for the Swedish compulsory school was introduced, affecting students born in 1996 and later.
  - The goal of the new curriculum was to re-write the syllabus of each course to ensure greater clarity.
- In 2011-12, the new grading scale was introduced.
  - This only affected those entering 8th grade from 2011 onward, so those in 9th grade continued under the old scale.
- In 2013-14 and onward students entering 7th grade began receiving grades from 7th grade.
- In 2013-14 and onward students entering 6th grade began receiving grades from 6th grade.

Reform Exposure

Cohort	5th Grade	6th Grade	7th Grade	8th Grade	9th Grade
1991	-	-	-	G/VG/MVG	G/VG/MVG
1992	-	-	-	G/VG/MVG	G/VG/MVG
1993	-	-	-	G/VG/MVG	G/VG/MVG
1994	-	-	-	G/VG/MVG	G/VG/MVG
1995	-	-	-	G/VG/MVG	G/VG/MVG
1996	-	-	-	G/VG/MVG	G/VG/MVG
1997	-	-	-	Letter Grades	Letter Grades
1998	-	-	-	Letter Grades	Letter Grades
1999	-	-	Letter Grades	Letter Grades	Letter Grades
2000	-	Letter Grades	Letter Grades	Letter Grades	Letter Grades

Reform Exposure

Cohort	5th Grade	6th Grade	7th Grade	8th Grade	9th Grade
1991	-	-	-	G/VG/MVG	G/VG/MVG
1992	-	-	-	G/VG/MVG	G/VG/MVG
1993	-	-	-	G/VG/MVG	G/VG/MVG
1994	-	-	-	G/VG/MVG	G/VG/MVG
1995	-	-	-	G/VG/MVG	G/VG/MVG
1996	-	-	-	G/VG/MVG	G/VG/MVG
1997	-	-	-	Letter Grades	Letter Grades
1998	-	-	-	Letter Grades	Letter Grades
1999	-	-	Letter Grades	Letter Grades	Letter Grades
2000	-	Letter Grades	Letter Grades	Letter Grades	Letter Grades

Data

Swedish Register Data[1]

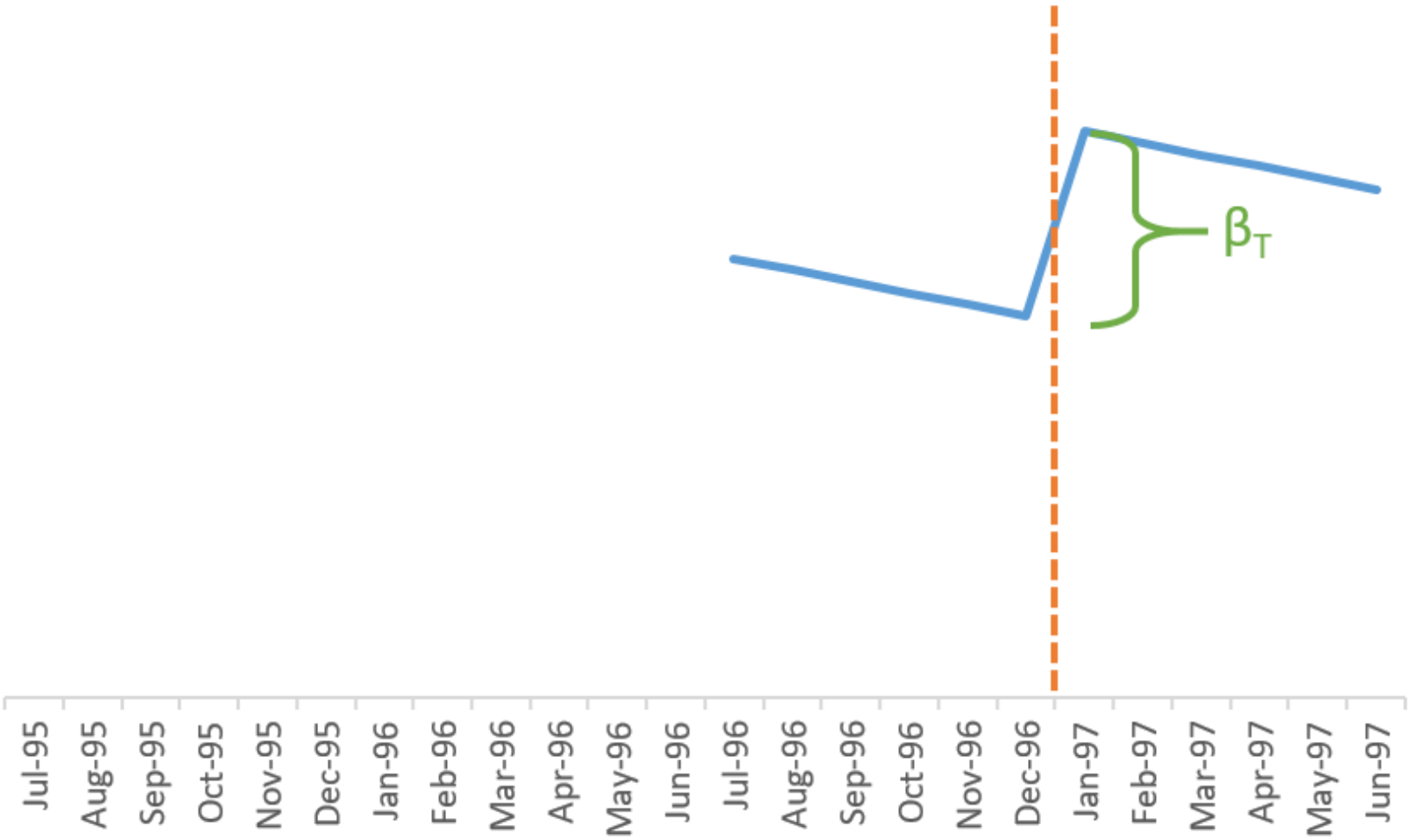
- Births from 1991 to 1997
- High School leavers
- University enrolments: Up to spring semester at age 21
- University credits: Up to autumn at age 20
- Inpatient and outpatient health data: Up to middle of 9th grade

[1]The data used in this paper comes from the Swedish Interdisciplinary Panel approved by the Regional Ethics Committee in Lund (2012/03).

Empirical Strategy

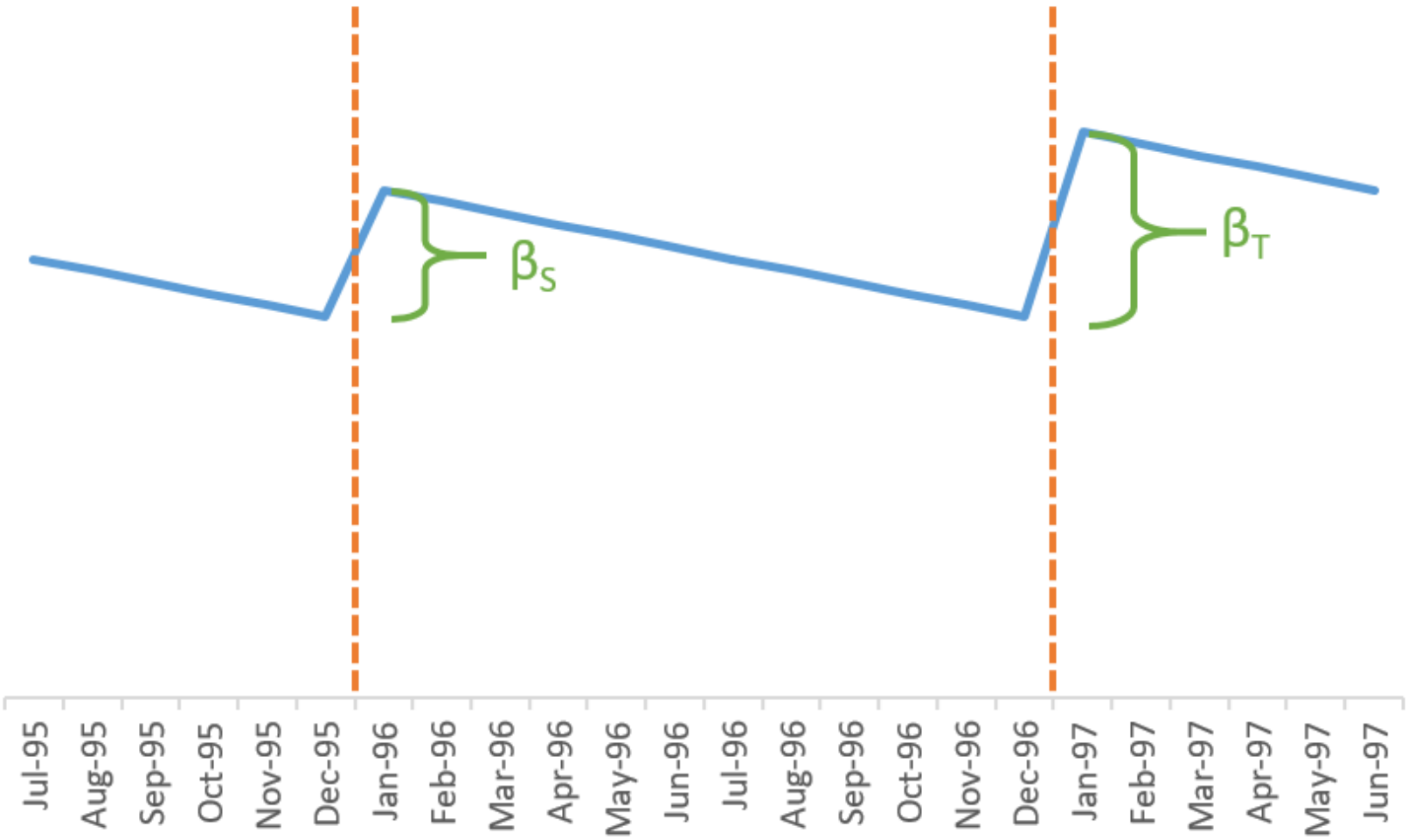
Identification

- Assignment to school cohort is based on date of birth
- This should lead us to an RD Design:



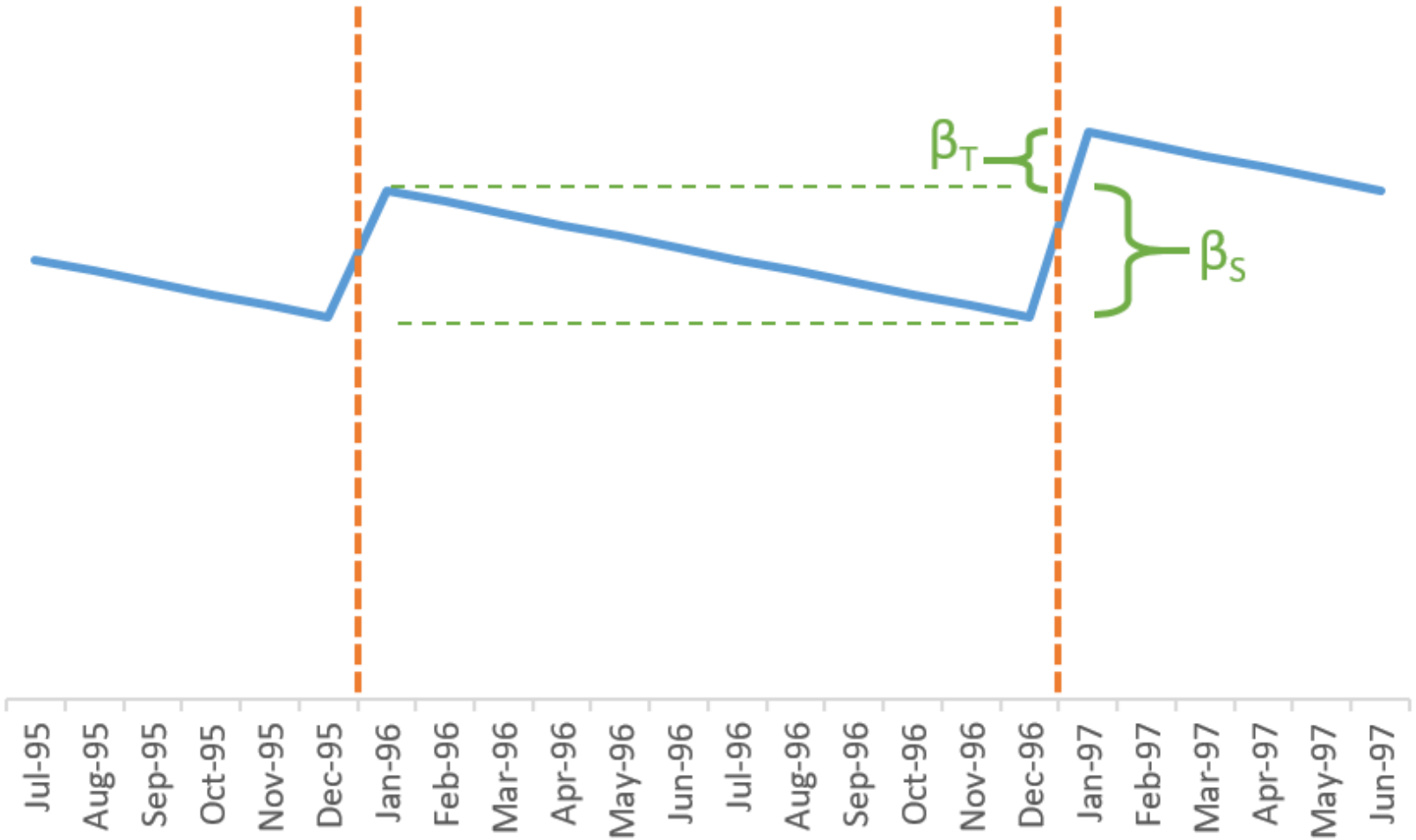
Identification

- This should lead us to an RD Design:
- BUT: Results confounded by school starting age effects



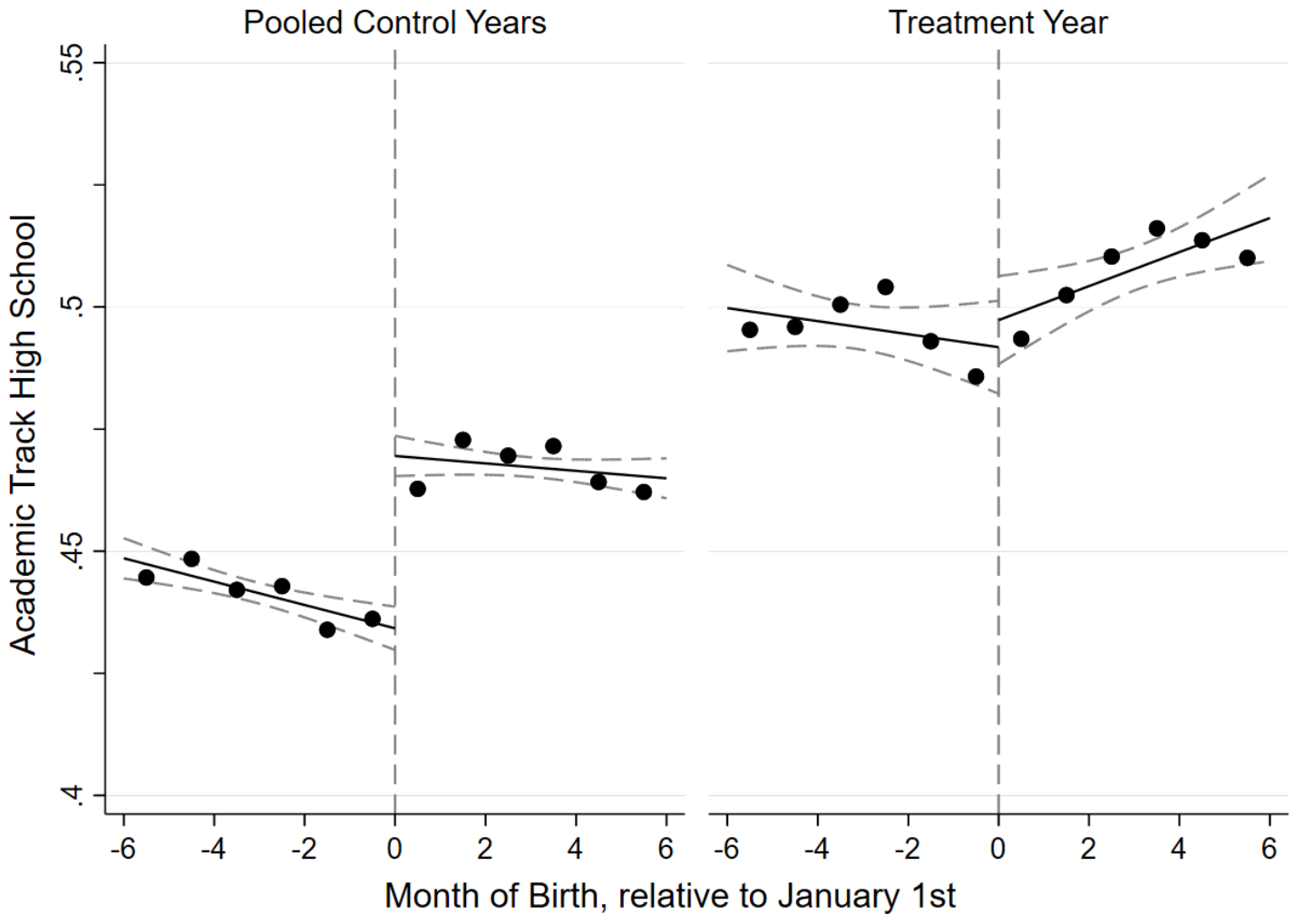
Identification

- BUT: Results confounded by school starting age effects
- Solution: Add placebo treatments to extract seasonal effect



Identification

- With real data:



Identification

- Difference-in-discontinuity model:

$$Y_i = \alpha_0 + \beta_0 \cdot 1[x_i \geq c] + \gamma_0 \cdot x_i + \gamma_1 \cdot 1[x_i \geq c] \cdot x_i$$
$$+ A_i \cdot \{\alpha_1 + \beta_1 \cdot 1[x_i \geq c] + \gamma_2 \cdot x_i + \gamma_3 \cdot 1[x_i \geq c] \cdot x_i\} + \epsilon_i$$

- x_i = month of birth, centered around January 1st (c)
- A_i = indicator for birth in 12 month period around January 1st, 1997

Identification

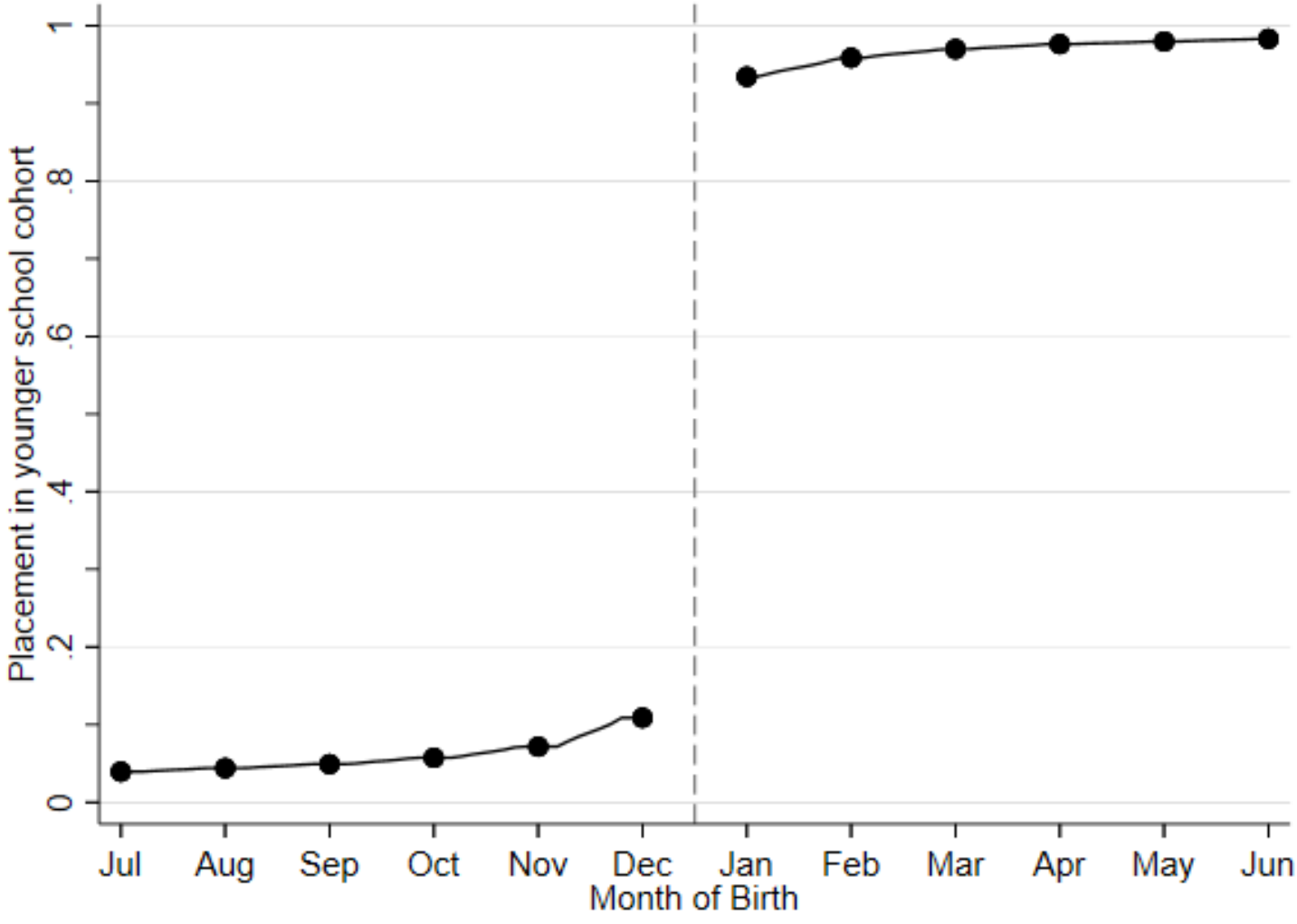
- BUT: Non-compliance with school cohort assignment
- Solution: Fuzzy difference-in-discontinuity model:

$$
\begin{aligned}
S_i &= \pi_0 + \delta_0 \cdot 1[x_i \geq c] + \rho_0 \cdot x_i + \rho_1 \cdot 1[x_i \geq c] \cdot x_i \\
&\quad + A_i \cdot \{\pi_1 + \delta_1 \cdot 1[x_i \geq c] + \rho_2 \cdot x_i + \rho_3 \cdot 1[x_i \geq c] \cdot x_i\} + \nu_i \\
Y_i &= \alpha_0 + \beta_0 \cdot \hat{S}_i + \gamma_0 \cdot x_i + \gamma_1 \cdot \hat{S}_i \cdot x_i \\
&\quad + A_i \cdot \{\alpha_1 + \beta_1 \cdot \hat{S}_i + \gamma_2 \cdot x_i + \gamma_3 \cdot \hat{S}_i \cdot x_i\} + \epsilon_i
\end{aligned}
$$

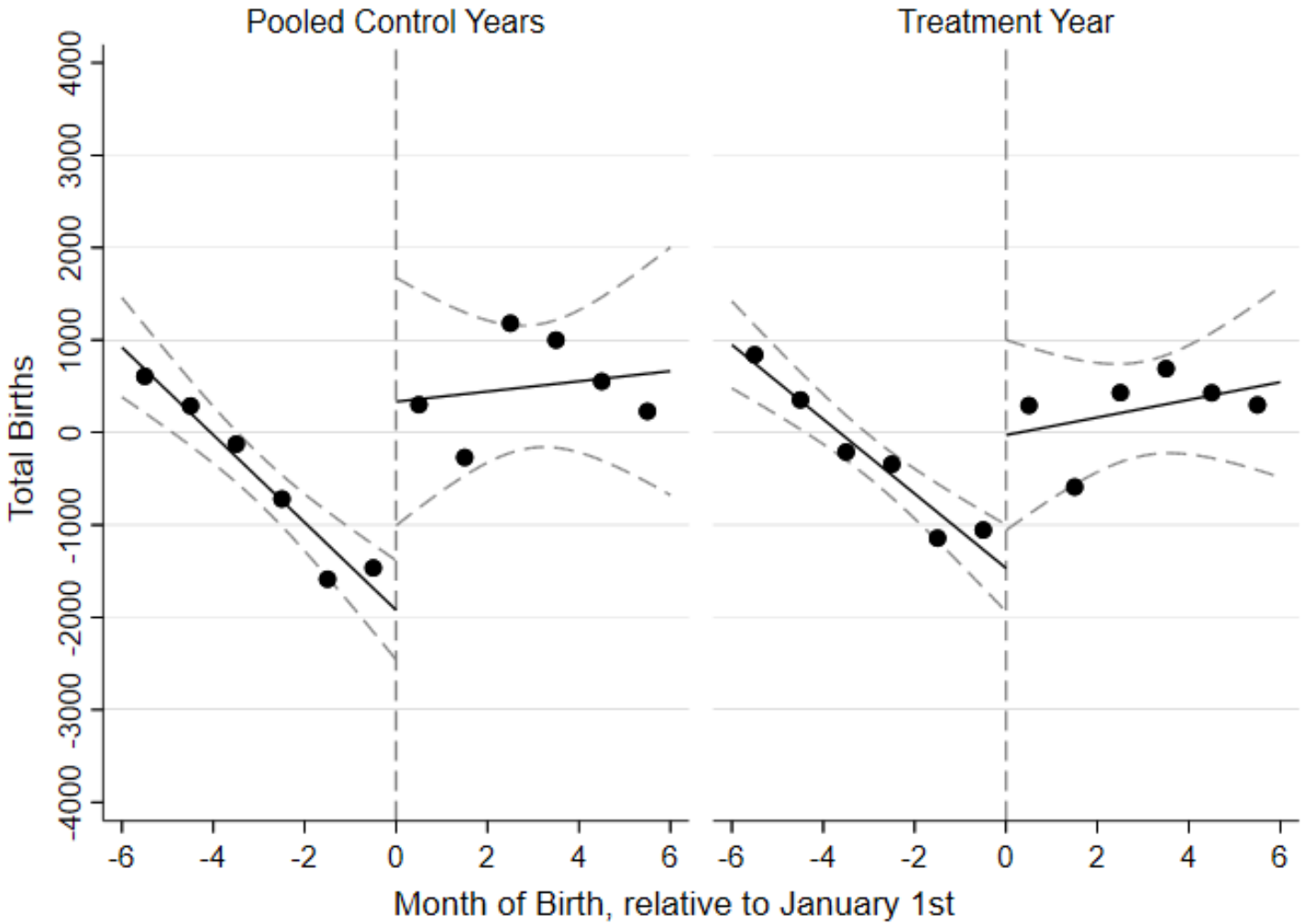
- x_i = month of birth, centered around January 1st (c)
- A_i = indicator for birth in 12 month period around January 1st, 1997
- S_i = indicator for being in school cohort with those born after January 1st, or later

Identification

- Compliance with assignment



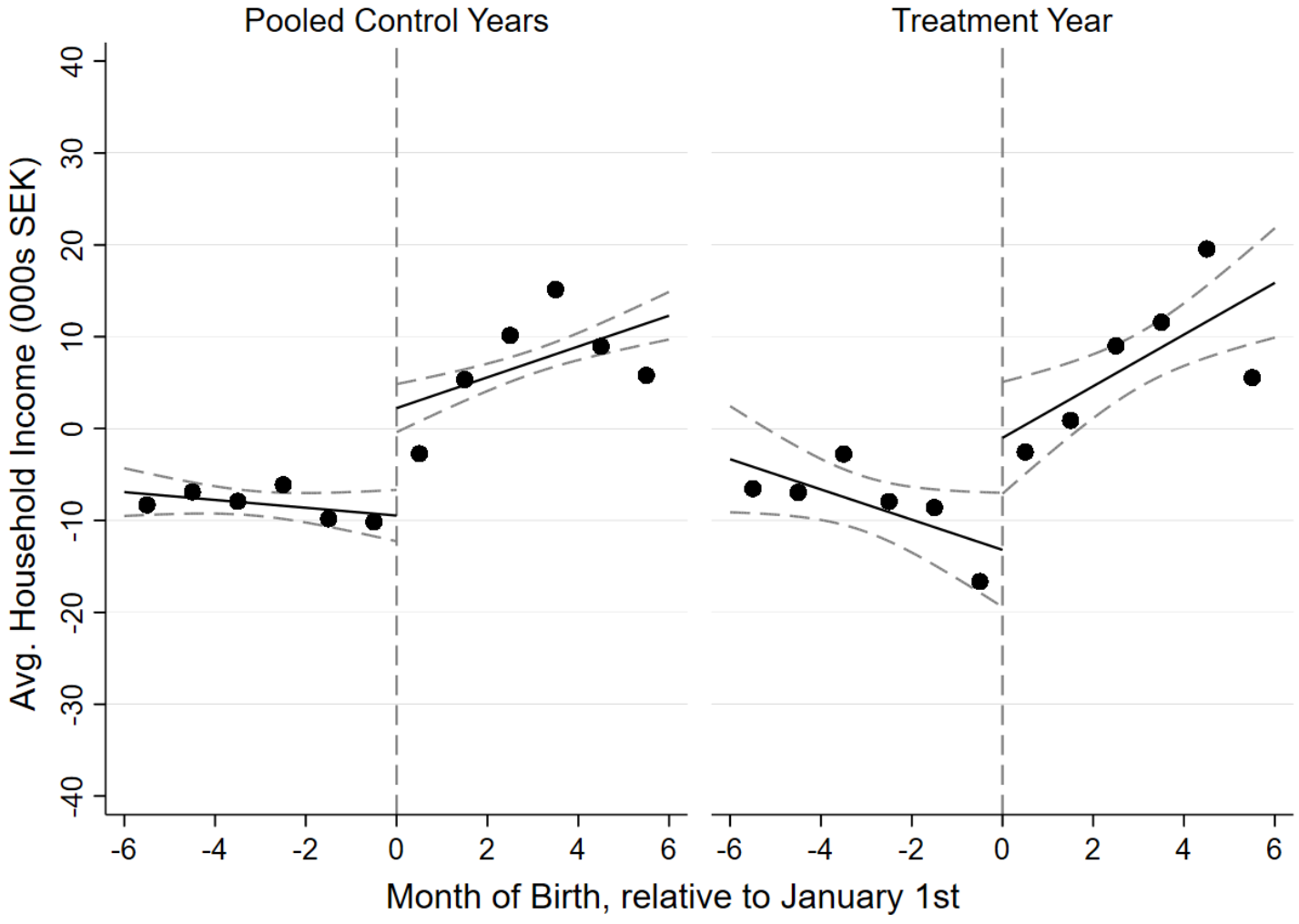
Testing - Density of the running variable



Regression Output

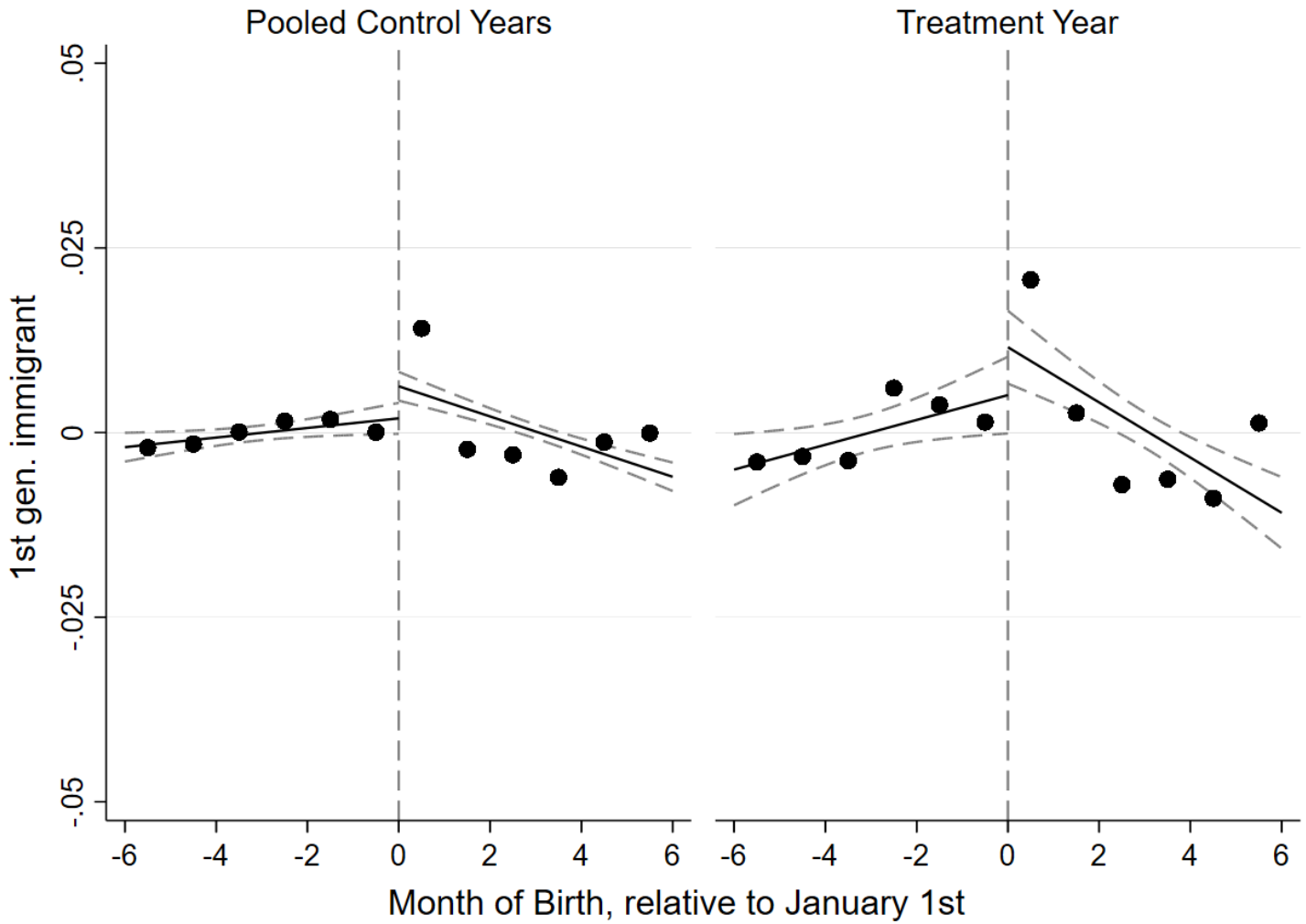
Testing - Covariate Balance

Average Household Income



Testing - Covariate Balance

First Generation Immigrant



Full Table of Balance Tests

Results

Outline

Results: High School Tracks

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.027***	–0.036***	–0.020***	0.000	–0.016***
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)
Pre-reform mean	.792	.455	.168	.23	.0534
N	545,759	545,759	545,759	545,759	545,759

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Results: University

	Enrolled Spring Age 21	In Top 5 University	No. of credits passed]	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.008	–0.001	–0.654*	–0.013***	0.001
	(0.008)	(0.006)	(0.370)	(0.005)	(0.004)
Pre-reform mean	.278	.127	9.22	.0837	.0527
N	541,301	541,301	541,301	508,014	508,014

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Outline

Gender Differences: High School

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.026**	–0.039***	–0.028***	0.001	–0.011**
	(0.011)	(0.012)	(0.010)	(0.010)	(0.005)
Reform*Female	–0.003	0.005	0.016	–0.003	–0.010
	(0.015)	(0.017)	(0.013)	(0.015)	(0.008)
Pre-reform: boys	.766	.401	.194	.171	.0331
Pre-reform: girls	.819	.512	.14	.292	.0745
N	545,759	545,759	545,759	545,759	545,759

Notes: Robust standard errors in parentheses. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Gender Differences: University

	Enrolled Spring Age 21	In Top 5 University	No. of credits passed	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.019*	–0.010	–0.796	–0.022***	0.006
	(0.010)	(0.007)	(0.485)	(0.008)	(0.005)
Reform*Female	0.020	0.017	0.244	0.017*	–0.010
	(0.015)	(0.011)	(0.739)	(0.010)	(0.008)
Pre-reform: boys	.239	.104	7.81	.114	.0386
Pre-reform: girls	.319	.151	10.7	.0516	.0679
N	541,301	541,301	541,301	508,014	508,014

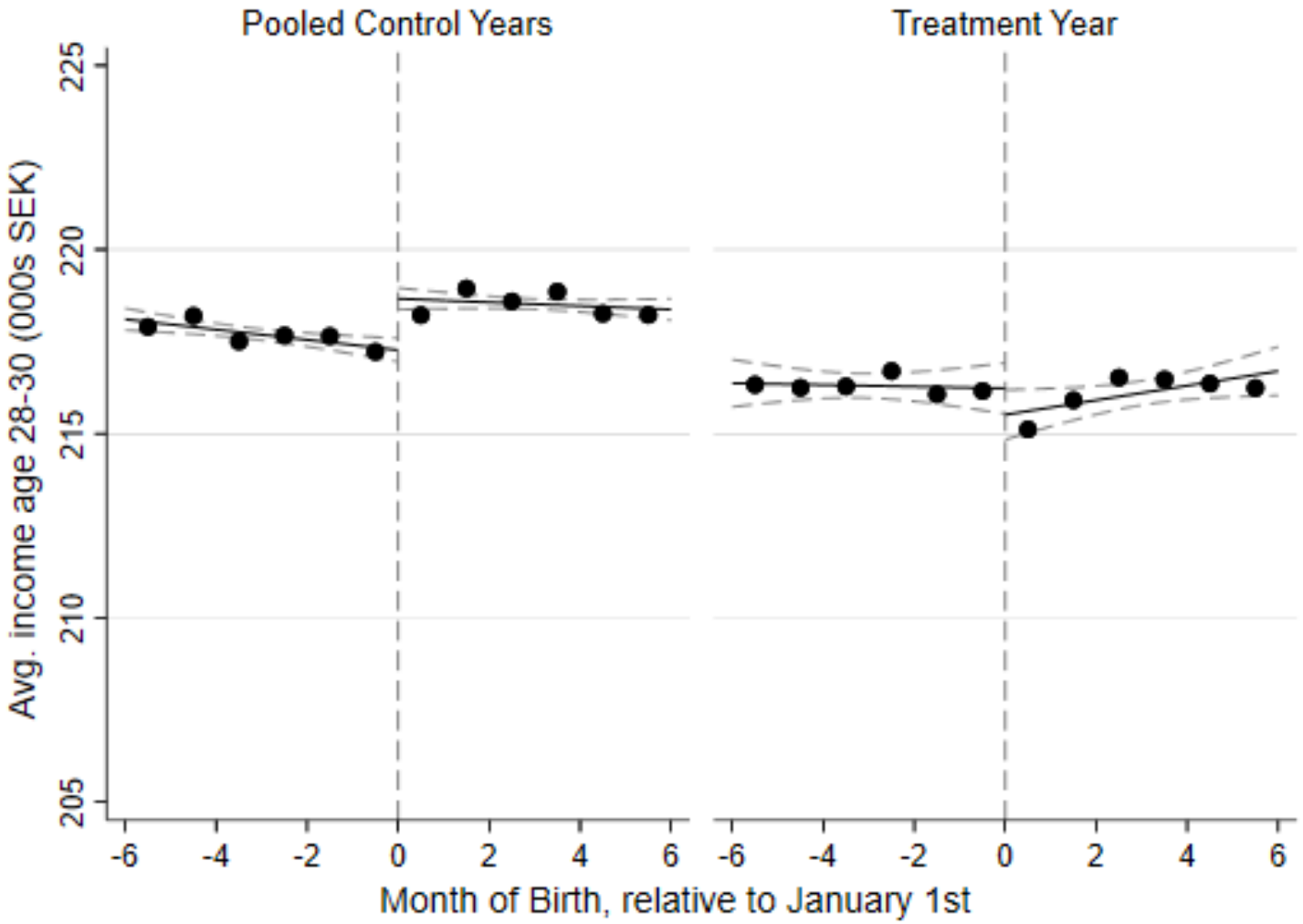
Notes: Robust standard errors in parentheses. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Outline

Surrogate Index

- Using adults born in 1985 and 1986 as surrogates, we predict average income between ages 28-30 for our sample as a function of our intermediate outcomes
- Athey et al. (2019): ATE of treatment on a surrogate index is equal to ATE on the true long-term outcome under the following assumptions:
  - Unconfoundedness
  - Comparability
  - Surrogacy

Income Age 28-30



Point estimate: – 2491.05 (643.546) Regression table

Outline

HBSC Data

The Health Behaviour of School Children survey

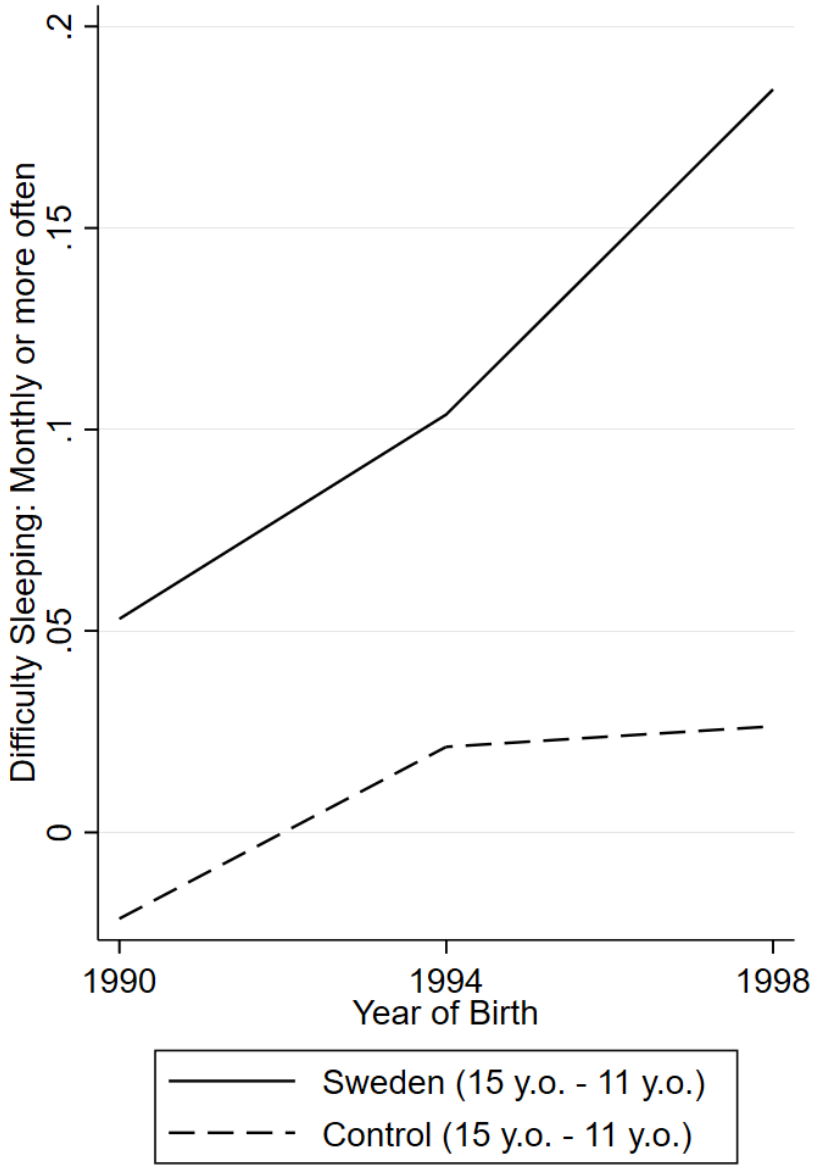
- Representative survey of 11, 13 and 15 year olds in over 50 countries/regions
- Undertaken by WHO every four years
- We use data from the 2002-2014 waves
- 1998 birth cohort were surveyed at age 11 in 2010 and age 15 in 2014

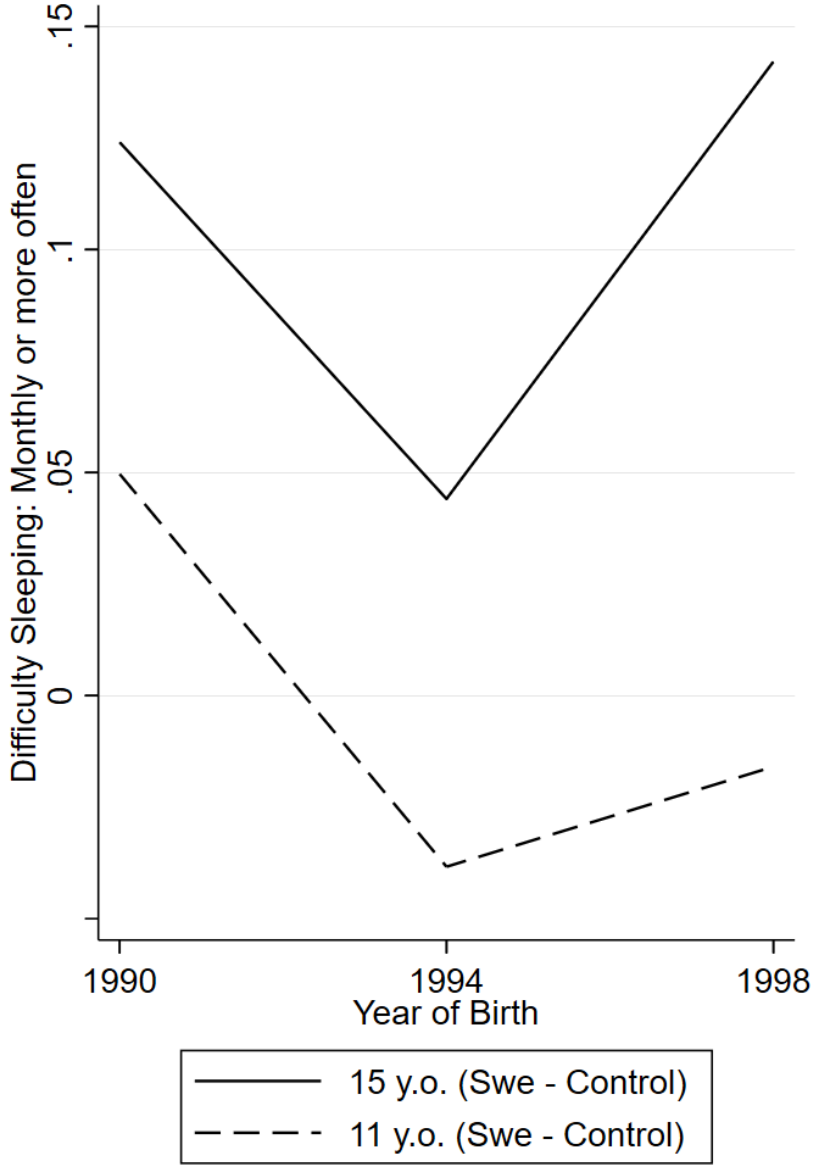
Identification Strategy

Triple Differences-in-differences, exploiting differences in responses:

1. between age groups (15 v 11)
2. between countries (Sweden v Denmark, Norway)
3. between birth cohorts (1998 v 1990, 1994)

Identification Strategy





Attitudes to School

	(1)	(2)	(3)
	Very good	Good/ Very good	Average/ Good/ Very good
Academic Ability	–0.085***	–0.190***	–0.020
	(0.025)	(0.030)	(0.012)
Pre-reform mean	.145	.581	.934
N	25,241	25,241	25,241
	A lot	A little/ A lot	Not much/ A little/ A lot
Like School	0.034	0.006	–0.014
	(0.033)	(0.027)	(0.014)
Pre-reform mean	.125	.682	.908
N	25,241	25,241	25,241
	A lot	A little/ A lot	Some/ A little/ A lot
School Pressure	0.020	0.116***†	0.118***
	(0.023)	(0.032)	(0.028)
Pre-reform mean	.2	.482	.924
N	25,241	25,241	25,241

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01. † evidence of non-parallel trends.

Mental Health (Register Data)

	(1) Any diagnosis	(2) No. of diagnoses
Health	0.002	0.015
	(0.003)	(0.013)
Self-harm	–0.000	–0.000
	(0.001)	(0.001)
Drugs	0.001	0.003*
	(0.001)	(0.002)
Anxiety	0.001	0.006
	(0.002)	(0.010)
Education	0.002	0.013*
	(0.002)	(0.008)
N	547,507	547,507

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Mental Health (HBSC Data)

	Monthly / more often	Weekly / more often	More than weekly / more often	Daily / more often
Irritable	0.010	0.033	0.046*	0.013
	(0.028)	(0.034)	(0.026)	(0.014)
Pre-reform mean	.88	.606	.321	.0729
N	25,241	25,241	25,241	25,241
Nervous	–0.025	–0.003	0.019	0.000
	(0.033)	(0.031)	(0.023)	(0.011)
Pre-reform mean	.734	.41	.173	.0389
N	25,241	25,241	25,241	25,241
Difficulty Sleeping	0.094***	0.112***	0.105***	0.057***
	(0.036)	(0.032)	(0.028)	(0.019)
Pre-reform mean	.642	.42	.245	.0931
N	25,241	25,241	25,241	25,241

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Outline

Placebo Tests: High School

	(1) Graduate High School	(2) Academic track	(3) Stem Track	(4) Econ./Soc.Sci./ Hum. Track	(5) Art Track
1992	0.005	–0.011	–0.002	–0.008	0.001
	(0.007)	(0.008)	(0.006)	(0.007)	(0.004)
1993	–0.001	–0.000	–0.002	–0.002	0.000
	(0.007)	(0.008)	(0.006)	(0.007)	(0.004)
1994	–0.016**	0.004	–0.005	0.007	0.001
	(0.007)	(0.008)	(0.006)	(0.007)	(0.004)
1996	0.012	0.009	0.010	0.004	–0.002
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)
N	449,486	449,486	449,486	449,486	449,486

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Placebo Tests: University

	(1) Enrolled Spring Age 21	(2) In Top 5 University	(3) No. of credits passed	(4) STEM Track	(5) Econ./Soc.Sci./ Hum. Track
1992	–0.003	–0.002	–0.024	0.001	0.003
	(0.007)	(0.006)	(0.361)	(0.005)	(0.004)
1993	–0.007	–0.006	–0.550	–0.002	–0.002
	(0.008)	(0.006)	(0.363)	(0.005)	(0.004)
1994	0.000	0.009	0.343	–0.007	0.002
	(0.008)	(0.006)	(0.368)	(0.005)	(0.004)
1996	0.011	–0.001	0.262	0.009*	–0.004
	(0.008)	(0.006)	(0.378)	(0.005)	(0.004)
N	445,536	445,536	445,536	417,045	417,045

Notes: Robust standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01.

Other Robustness Checks

- Randomisation Inference
- Excluding specific control years
- Adding covariates
- Reduced bandwidth
- Higher polynomial orders
- Reduced form regressions

Summary

Summary/ Policy Implications

- Greater information reduces students self-confidence and affects mental health
- This leads to worse academic outcomes and less STEM enrolment
- We estimate that this has a negative long-term effect on earnings
- When it comes to the information content of grades, less is more

Thanks!

Questions/Suggestions?

Covariate Balance

	b	(se)
Total monthly births	–814.544	(511.889)
N	60	

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back

Covariate Balance

	b	(se)
Sex	0.005	(0.009)
Number of siblings	0.040	(0.027)
Birth order	0.005	(0.022)
Twins	0.004	(0.003)
Triplets or more	0.001***	(0.000)
Adoptive parents	0.003	(0.002)
Two adoptive parents	0.004**	(0.002)
Immigrant (1st generation)	0.003	(0.005)
Immigrant (2nd generation)	0.006	(0.005)
Mother has HS degree	–0.009	(0.005)
Mother has Uni. Degree	–0.010	(0.008)
Father has HS degree	–0.002	(0.006)
Father has Uni. degree	–0.005	(0.007)
Mother, STEM	–0.007	(0.005)
Father, STEM	0.003	(0.009)
Household income	–1803.401	(5794.428)
School class size	0.082	(0.095)
N	506,950	

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back

Surrogate Index

	Avg. Income Age 28-30
Grading Reform	–2491.05***
	(643.546)
Pre-reform mean	218,136
N	508,014

Notes: Robust standard errors in parentheses. $*$ p$<$0.10 $**$ p$<$0.05 $***$ p$<$0.01.

Back

Randomisation Inference

Table: Randomisation Inference

	Original p-value	R.I. p-value
Finish High School	0.00	0.02
Academic Track High School	0.00	0.02
STEM Track High School	0.00	0.04
Econ./ Soc. Sci./ Hum. Track High School	0.98	0.49
Art Track High School	0.00	0.05
Enrolled in uni spring age 21	0.28	0.12
Enrolled in a top 5 university	0.83	0.44
University credits passed	0.08	0.00
STEM track university	0.01	0.13
Econ./ Soc. Sci./ Hum. Track university	0.84	0.46
Avg. Income aged 28-30 (Surrogate)	0.00	0.00

Back

Excluding Control Years: High School

	(1) Graduate High School	(2) Academic track	(3) Stem Track	(4) Econ./Soc.Sci./ Hum. Track	(5) Art Track
1992	–0.025***	–0.039***	–0.021***	–0.002	–0.016***
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)
1993	–0.027***	–0.036***	–0.021***	–0.000	–0.016***
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)
1994	–0.031***	–0.035***	–0.021***	0.002	–0.016***
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)
1996	–0.024***	–0.034***	–0.018***	0.001	–0.016***
	(0.008)	(0.009)	(0.007)	(0.008)	(0.004)

Notes: Robust standard errors in parentheses. $*$ p$<$0.10 $**$ p$<$0.05 $***$ p$<$0.01.

Back

Excluding Control Years: University

	(1) Enrolled Spring Age 21	(2) In Top 5 University	(3) No. of credits finished	(4) STEM Track	(5) Econ./Soc.Sci./ Hum. Track
1992	–0.009	–0.002	–0.659*	–0.013**	0.002
	(0.008)	(0.006)	(0.382)	(0.005)	(0.004)
1993	–0.010	–0.003	–0.795**	–0.014***	0.000
	(0.008)	(0.006)	(0.382)	(0.005)	(0.004)
1994	–0.008	0.001	–0.568	–0.015***	0.001
	(0.008)	(0.006)	(0.382)	(0.005)	(0.004)
1996	–0.006	–0.001	–0.596	–0.011**	–0.000
	(0.008)	(0.006)	(0.380)	(0.005)	(0.004)

Notes: Robust standard errors in parentheses. $*$ p$<$0.10 $**$ p$<$0.05 $***$ p$<$0.01.

Back

Adding Covariates

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.023***	–0.032***	–0.018***	0.000	–0.015***
	(0.007)	(0.008)	(0.006)	(0.007)	(0.004)
N	529,355	529,355	529,355	529,355	529,355
	Enrolled Spring Age 21	In Top 5 University	No. of credits passed	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.008	–0.001	–0.604*	–0.013***	0.002
	(0.007)	(0.006)	(0.366)	(0.005)	(0.004)
N	525,236	525,236	525,236	492,535	492,535

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back

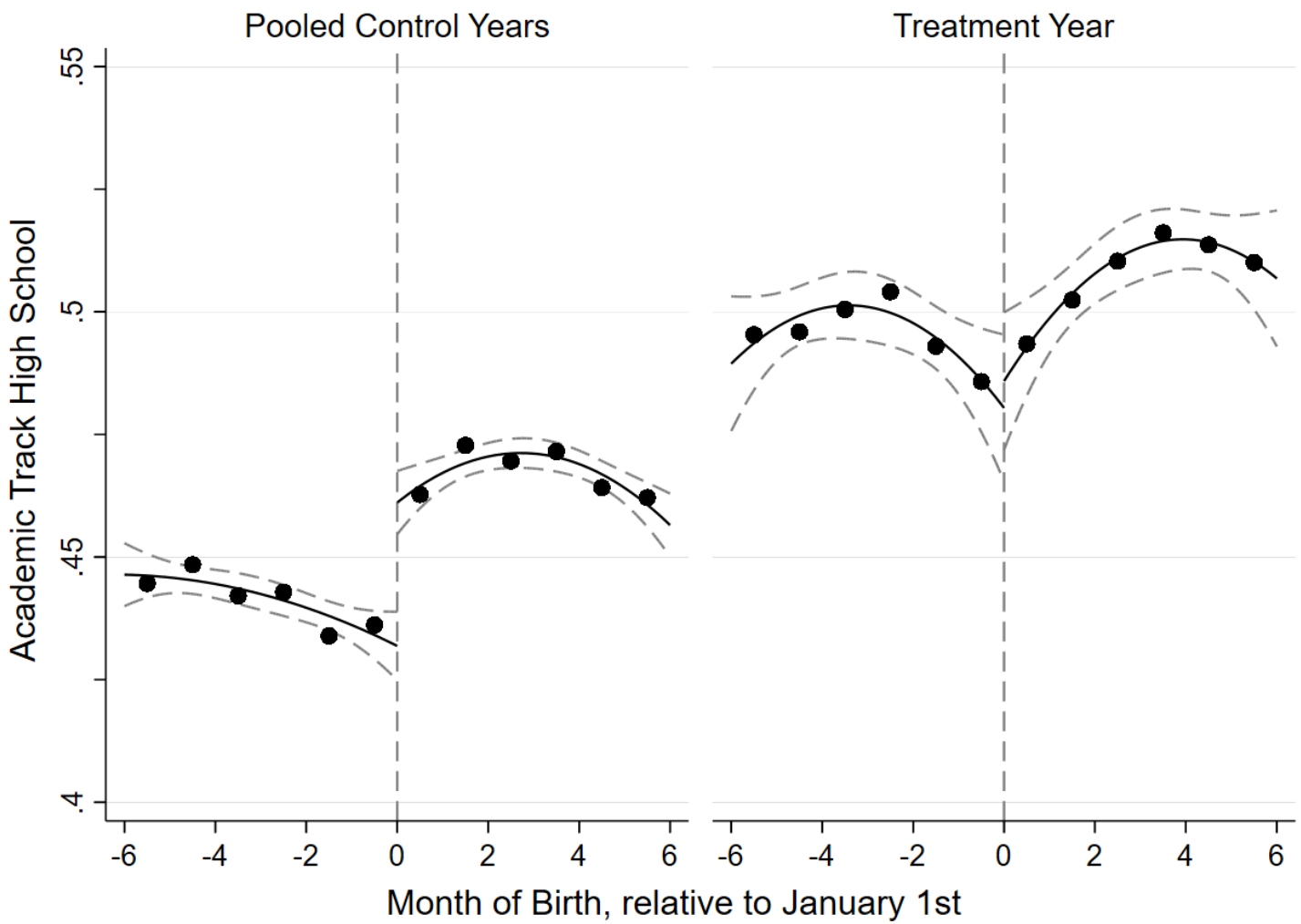
Reduced Bandwidth

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.027**	–0.027**	–0.024**	0.013	–0.016**
	(0.012)	(0.013)	(0.010)	(0.012)	(0.006)
N	260,780	260,780	260,780	260,780	260,780
	Enrolled Spring Age 21	In Top 5 University	No. of credits passed	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.012	0.000	–1.186**	–0.016**	0.008
	(0.012)	(0.009)	(0.568)	(0.008)	(0.006)
N	258,653	258,653	258,653	242,763	242,763

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back

Higher Polynomial Orders



Back

Higher Polynomial Orders

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.029**	–0.030**	–0.023**	0.013	–0.020***
	(0.012)	(0.014)	(0.011)	(0.012)	(0.007)
N	545,759	545,759	545,759	545,759	545,759
	Enrolled Spring Age 21	In Top 5 University	No. of credits passed	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.014	0.000	–1.383**	–0.017**	0.013**
	(0.013)	(0.009)	(0.602)	(0.008)	(0.007)
N	541,301	541,301	541,301	508,014	508,014

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back

Reduced Form Regressions

	Graduate High School	Academic track	Stem Track	Econ./Soc.Sci./ Hum. Track	Art Track
Grading Reform	–0.023***	–0.030***	–0.017***	0.000	–0.013***
	(0.006)	(0.007)	(0.006)	(0.006)	(0.004)
N	545,759	545,759	545,759	545,759	545,759
	Enrolled Spring Age 21	In Top 5 University	No. of credits passed	STEM Track	Econ./Soc.Sci./ Hum. Track
Grading Reform	–0.007	–0.001	–0.552*	–0.011***	0.001
	(0.007)	(0.005)	(0.312)	(0.004)	(0.003)
N	541,301	541,301	541,301	508,014	508,014

Notes: Robust standard errors in parentheses. $*$ p<0.10 $**$ p<0.05 $***$ p<0.01.

Back