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Effects of School Segregation on Educational Achievement along the Educational Trajectory in Germany

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u^b Introduction

u^b Point of Departure

Coleman-Report

“[C]hildren from a given family background, when put in schools of different social composition, will achieve at quite different levels.”

Coleman et al., 1966: 22

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Ample Research on School Segregation

Generally: Higher achievement gains in high-SES schools

- **Reviews**

Van Ewijk & Sleegers, 2010; Reardon & Owens, 2014; Holzberger et al., 2020; Perry & Lubienski, 2022; Rich & Owens, 2023

- **Methodological criticism (“phantom effects”)**

Koedel et al., 2015; Timmermans & Thomas, 2015; Marks, 2017; Spaiser et al., 2018; Sciffer et al., 2020

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Less often: Life-Course Perspective

Research Question 1: Timing

Principle of timing in lives:

- “The developmental impact of a succession of life transitions or events is contingent on when they occur in a person's life” Elder, 1998: 3.
- Most research (at least for Europe) focuses on secondary schools, earlier educational stages are less researched.

⇒ Research Question 1:

Does school composition impacts students differently in primary and secondary schools?

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Less often: Life-Course Perspective

Research Questions 2: Accumulation

Accumulation of disadvantages over time:

⇒ Research Question 2a:

Do effects of school composition increase, decrease, or persist over time?
(short vs. mid-term)

⇒ Research Question 2b:

Is there a difference in this trend between primary and secondary schools?

u^b Data & Methods

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Data

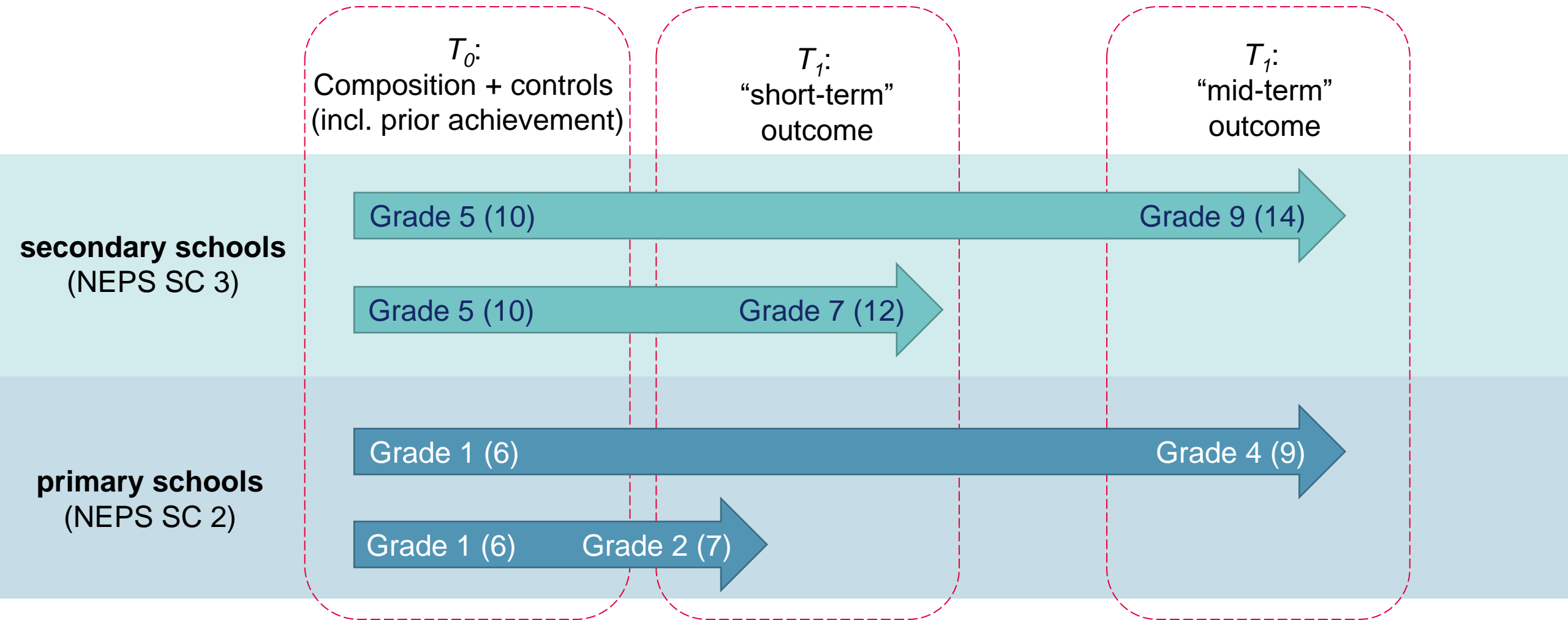
National Educational Panel Study (NEPS)

- Longitudinal data on educational processes and competence development in Germany
NEPS Network 2020, 2021
- Multiple starting cohorts (SC) starting at different ages
- Information provided by students, parents, (educators) and principals

u^b Methodological Approach

- Multilevel (Linear Mixed-Effects) Regression Models (students nested in schools)
 - Outcome: Competence score in math at T_1 , share low-SES students and control variables at T_0
 - “Lagged score value-added model” specification for some models
 - Restricted maximum likelihood estimation
- Multiple imputation of missing values due to item non-response (but not panel attrition)
 - Multilevel imputation models, mirroring analytical models + some information from other waves
 - Plausible value (PV) imputation for math achievement, accounting for measurement error
 - Latent means for aggregated variables (share low-SES students, achievement level), accounting for sampling error (students sampled within school)

u^b Design



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Variables

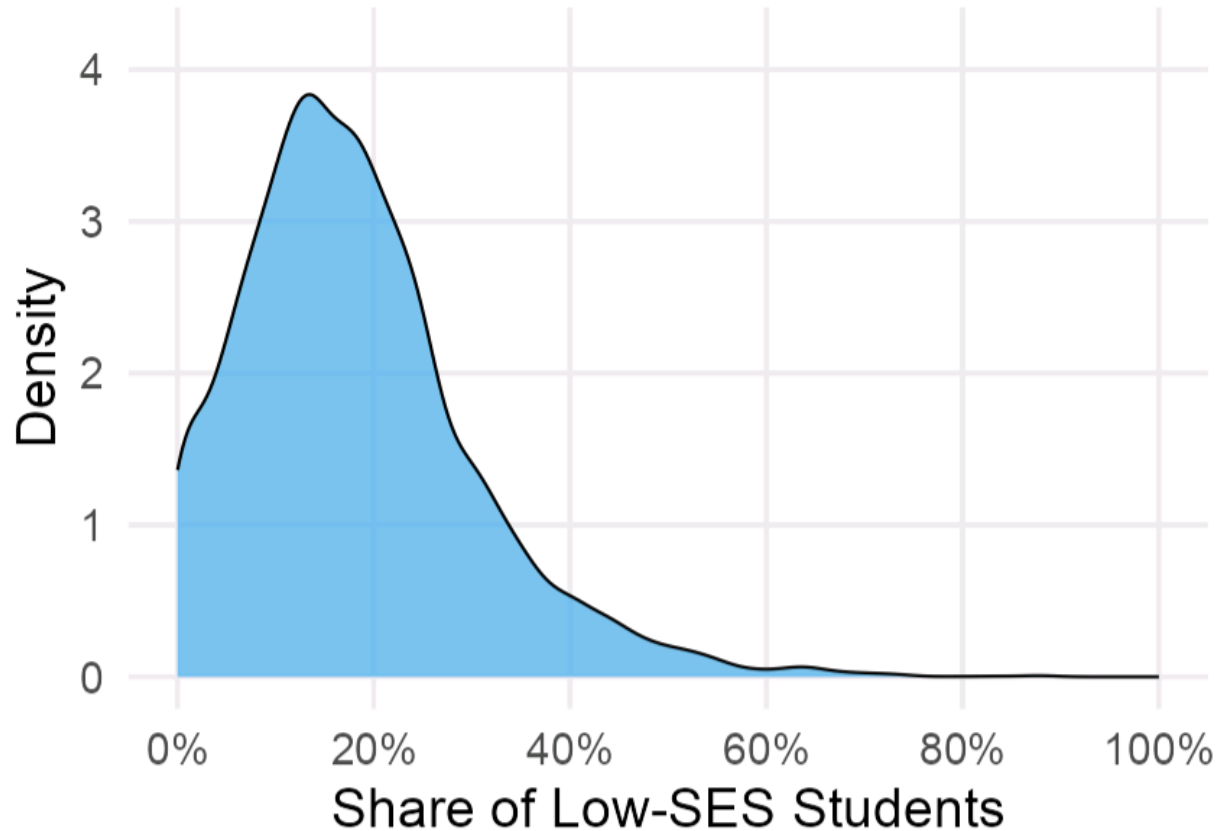
- **Student**
 - **Longitudinal competence score in math (T_1 & T_0)**
 - SES
(PISA inspired composite: highest ISEI & education of parents, books at home)
 - Gender
 - Migration status
 - Independence
 - Integration
 - Enjoyment
- **School**
 - **Share of low-SES students** (lowest 20%, aggregated)
 - Condition of school
 - Number of competing institutions
 - Share of young (<35) teachers
 - Urbanity
 - Achievement level (aggregated)
 - Tracks (secondary school)
- **Federal State**
 - East-west
 - Poverty quota
(Statistisches Bundesamt, 2015)
 - Share private schools
(Statistisches Amt des Bundes und der Länder, 2020)

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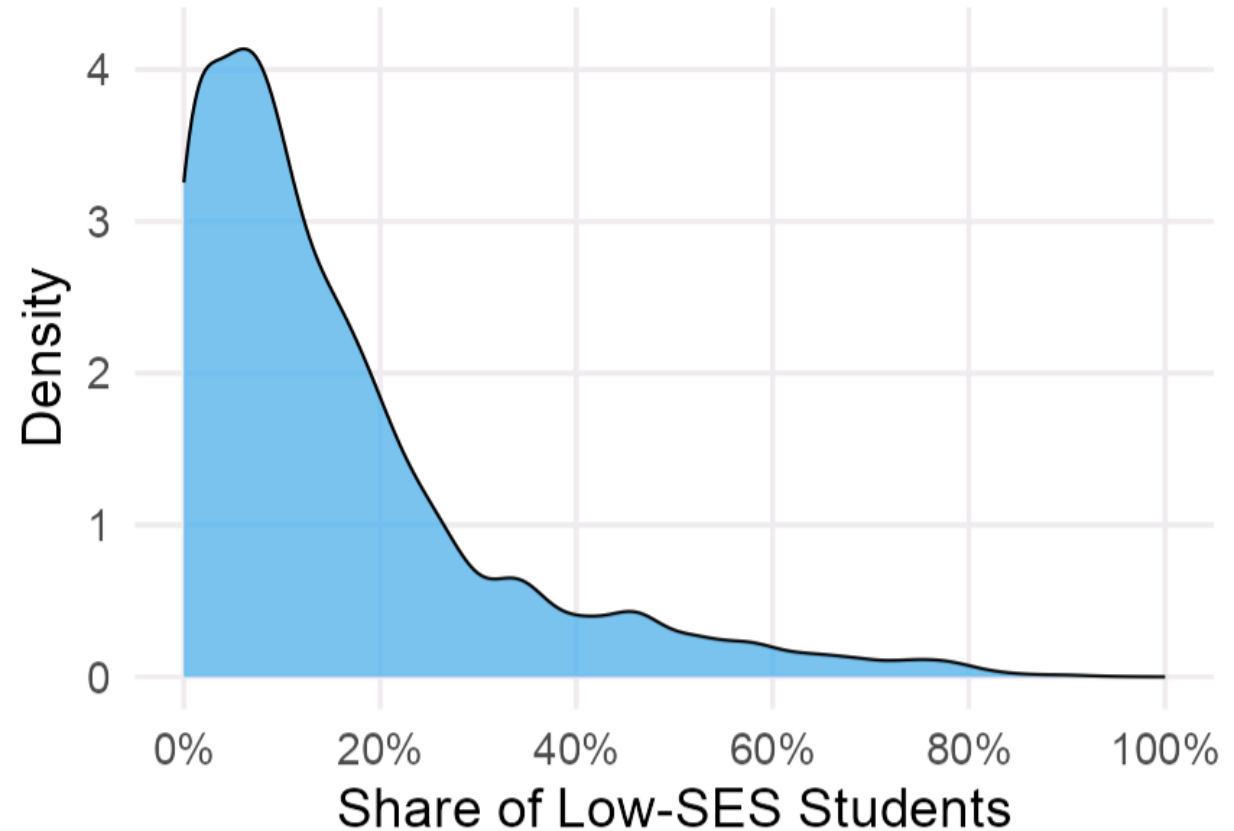
Distribution of School Composition

Socioeconomic School Composition by Educational Stage

Primary Schools



Secondary Schools

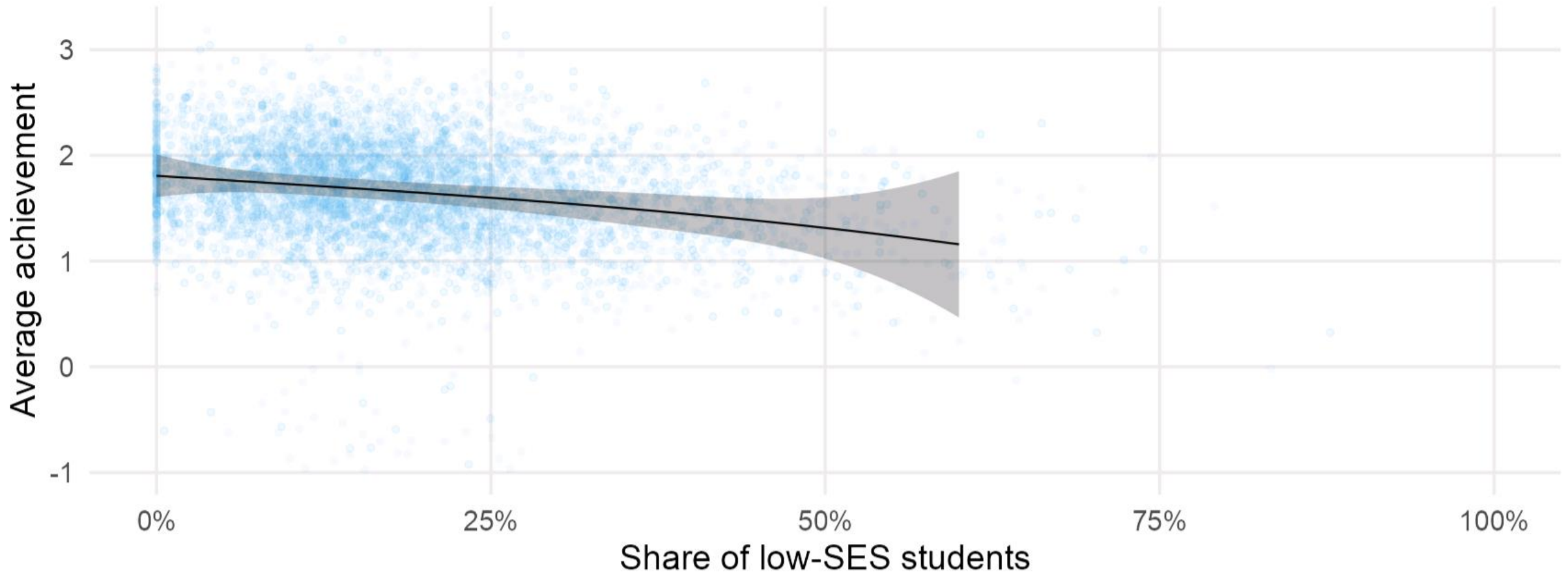


u^b Results
primary schools

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Composition and Math Competences

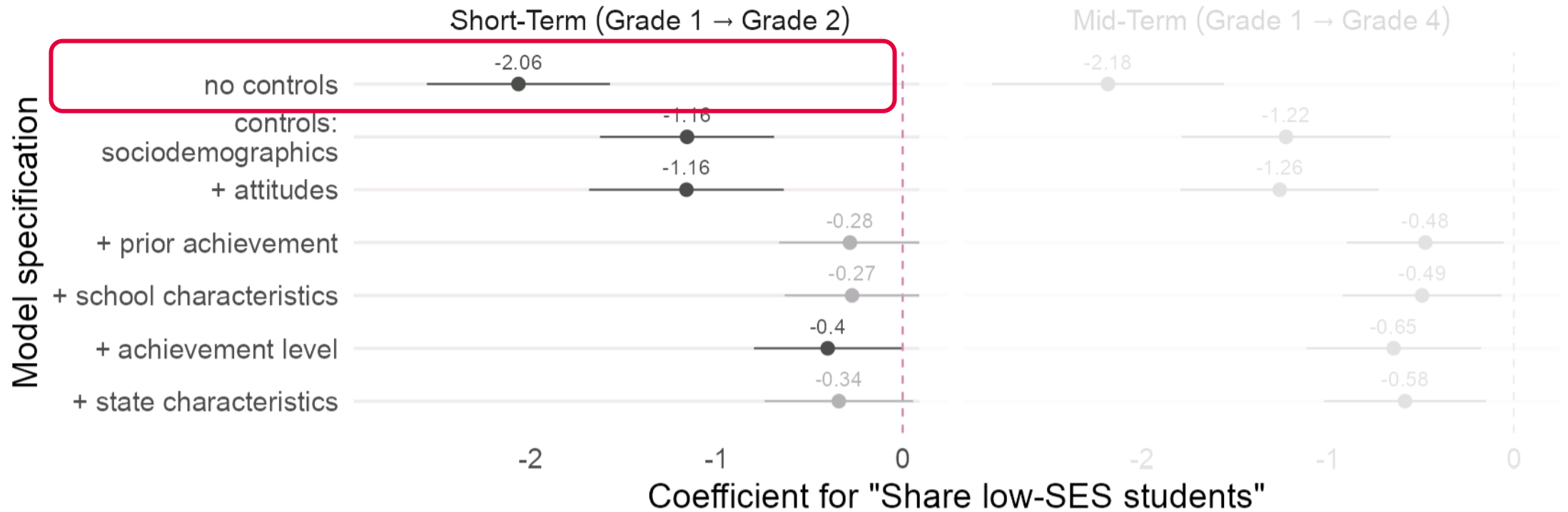
Achievement levels of primary schools vs share of low-SES students



u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Primary School Sample

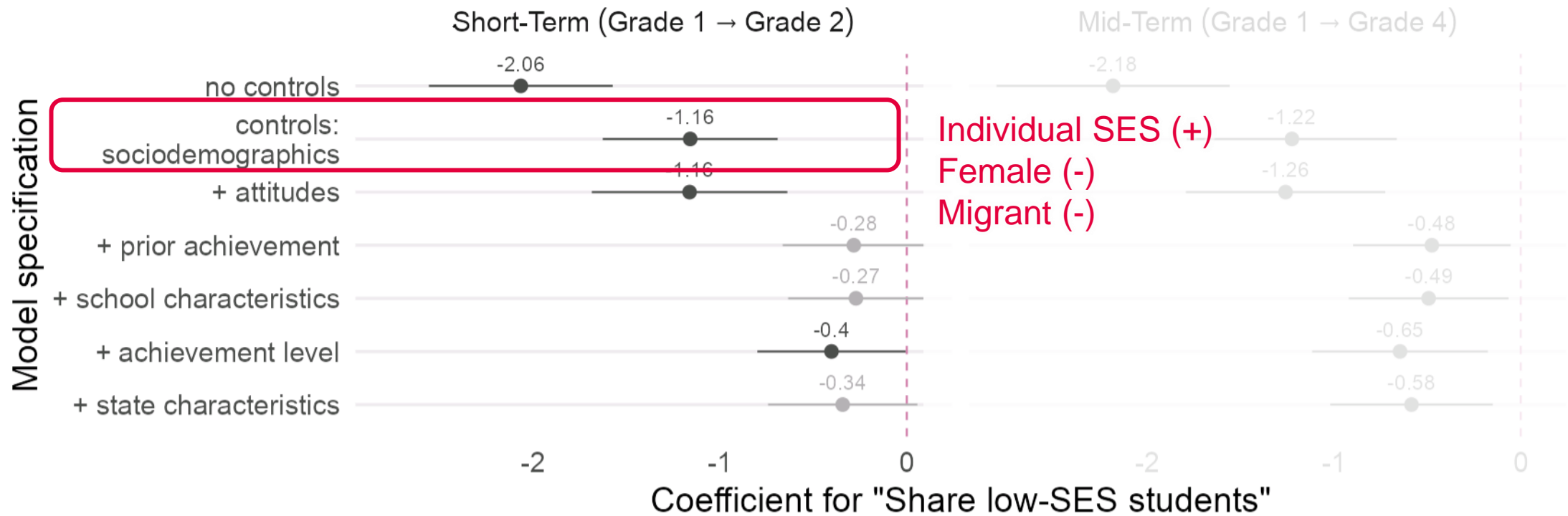


Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Primary School Sample

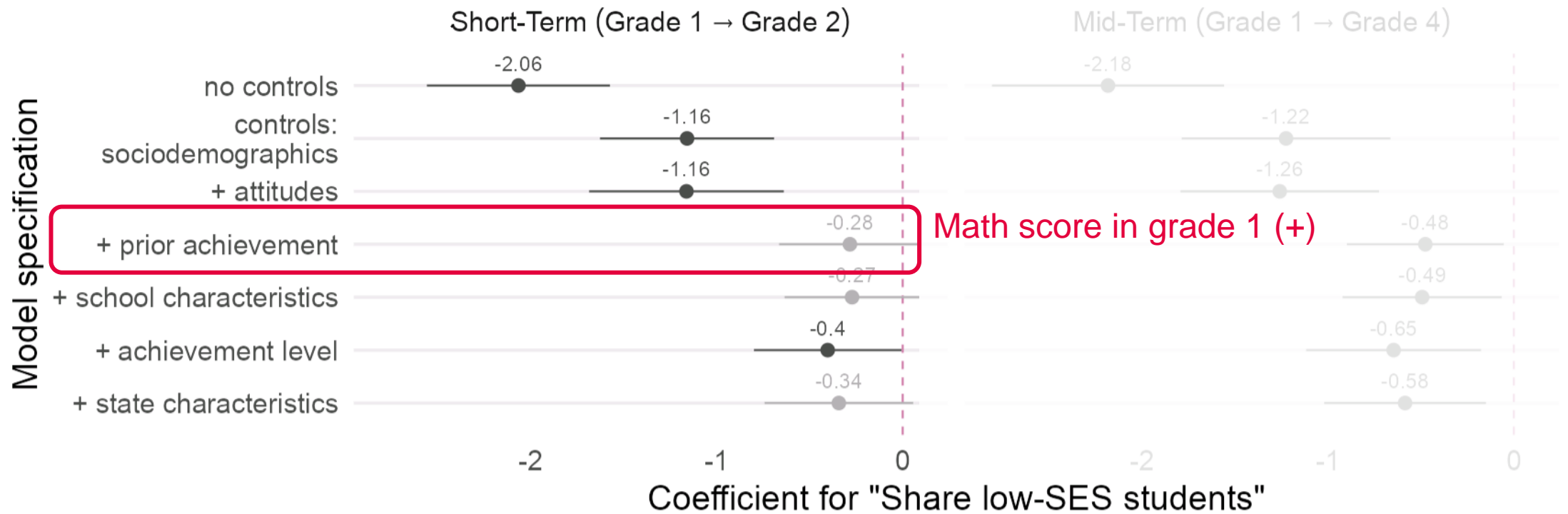


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u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Primary School Sample

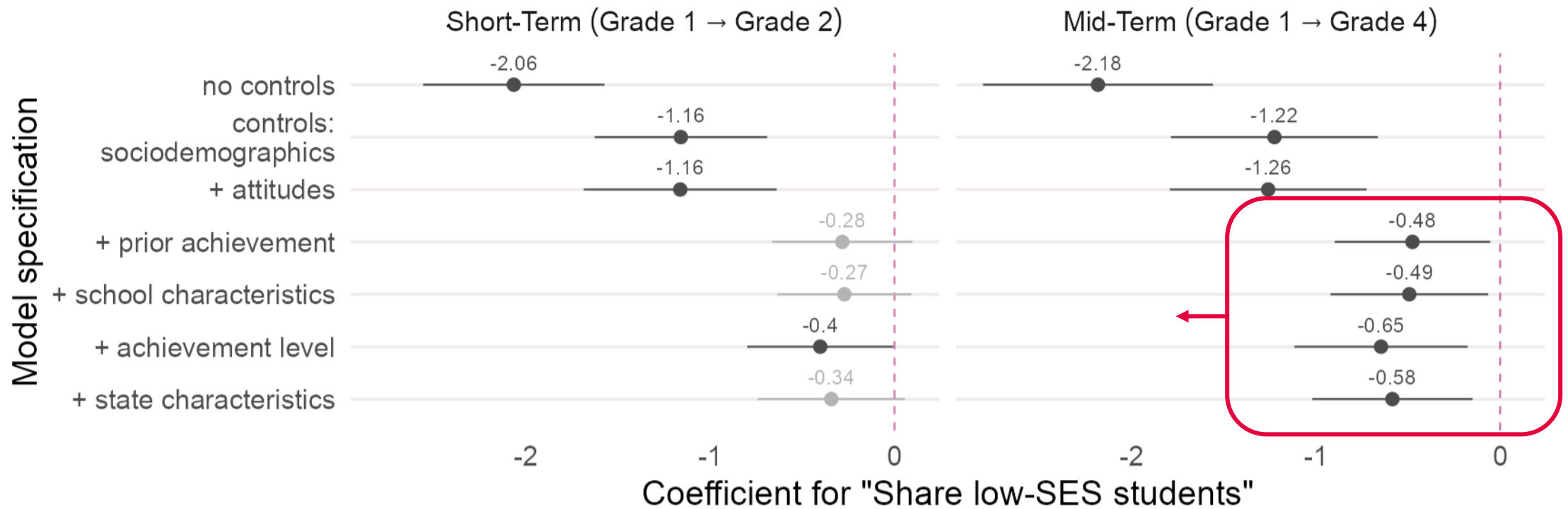


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u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Primary School Sample



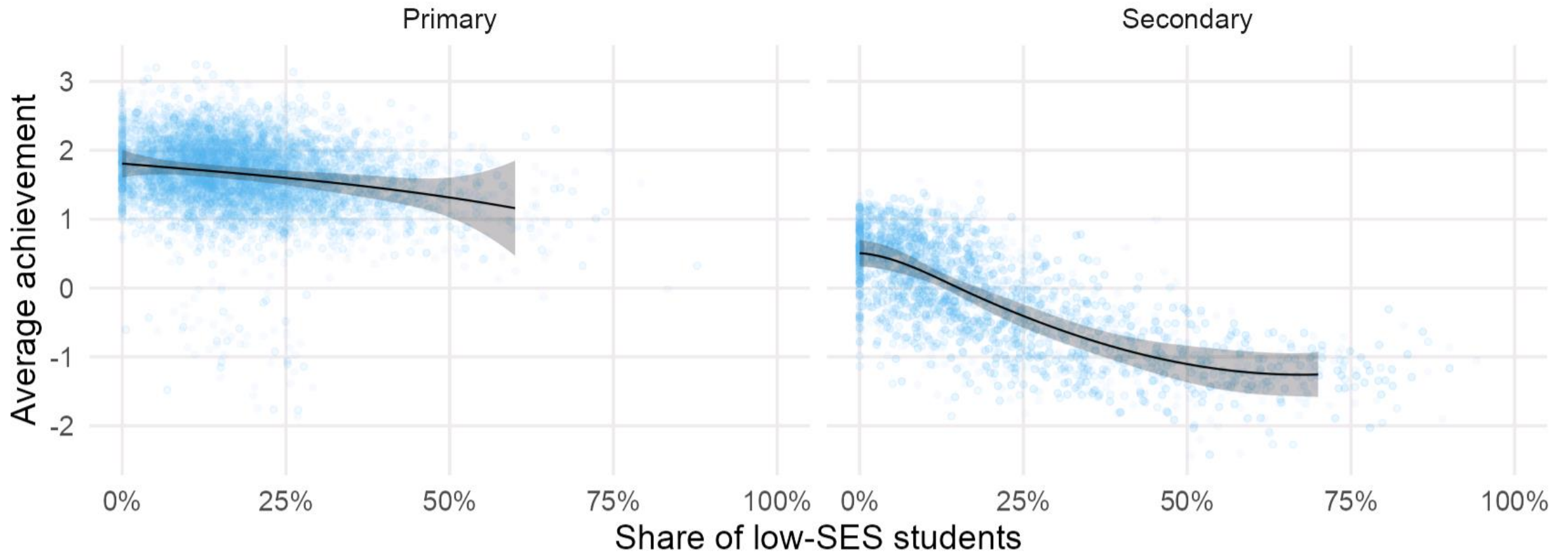
Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Results
secondary schools

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Composition and Math Competences

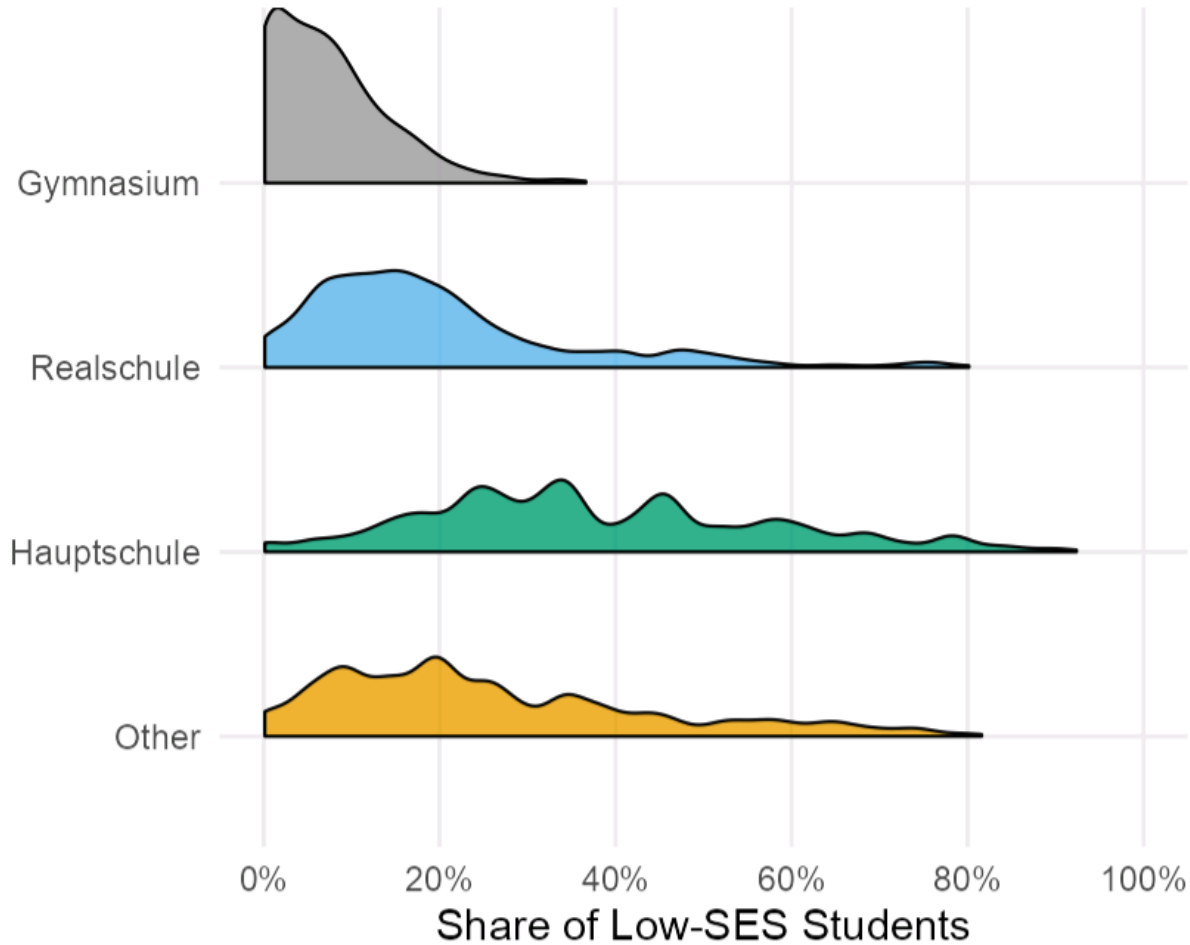
Achievement levels of schools vs share of low-SES students



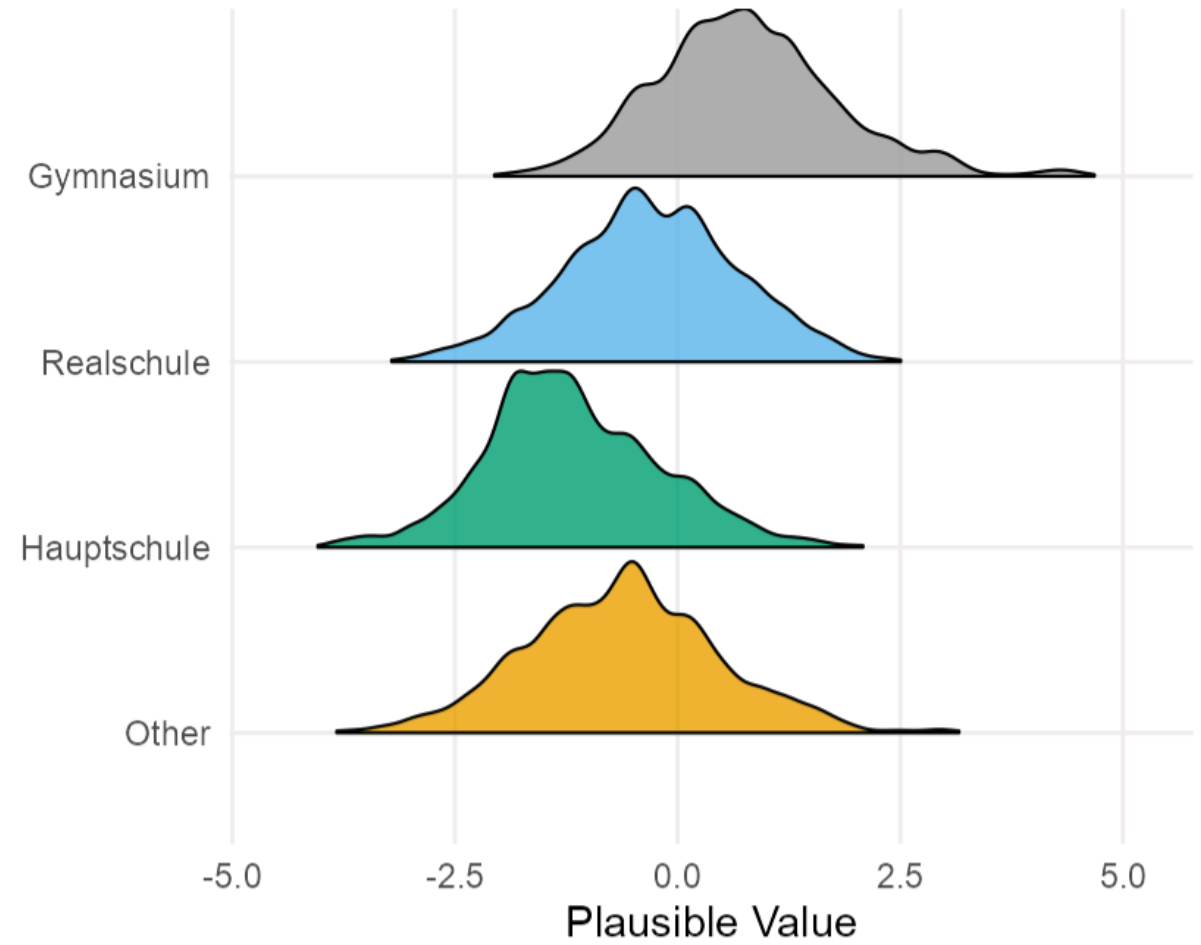
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Tracking, the elephant in the room

School Composition



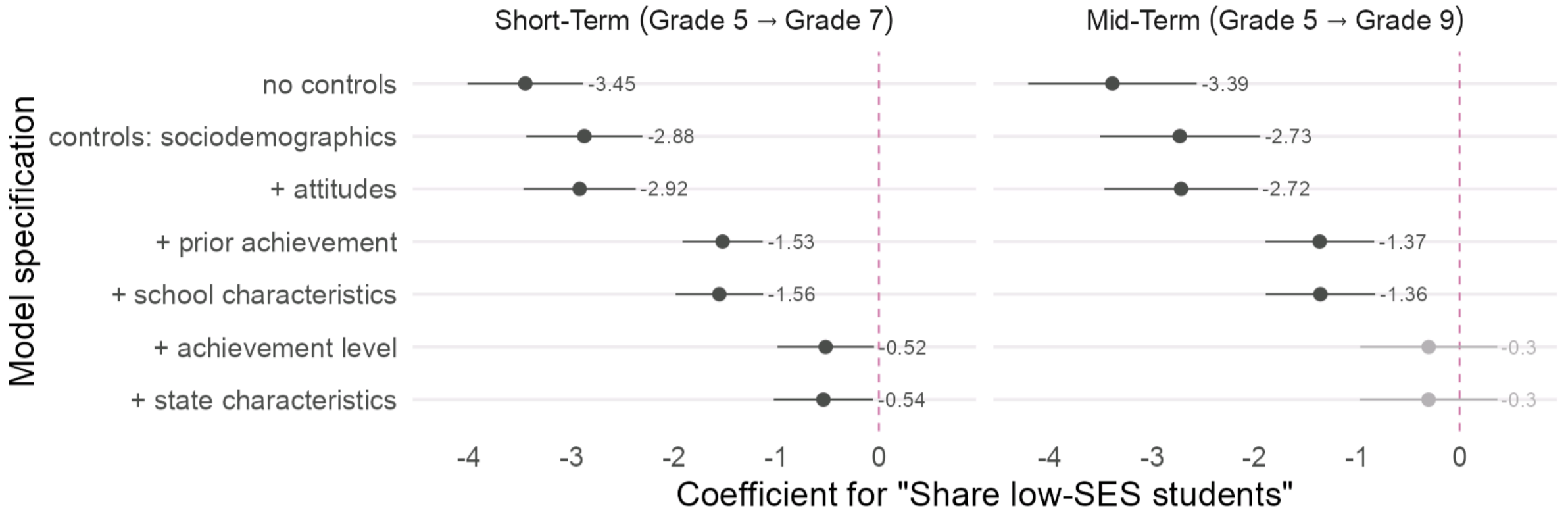
Math Achievement



u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Secondary School Sample

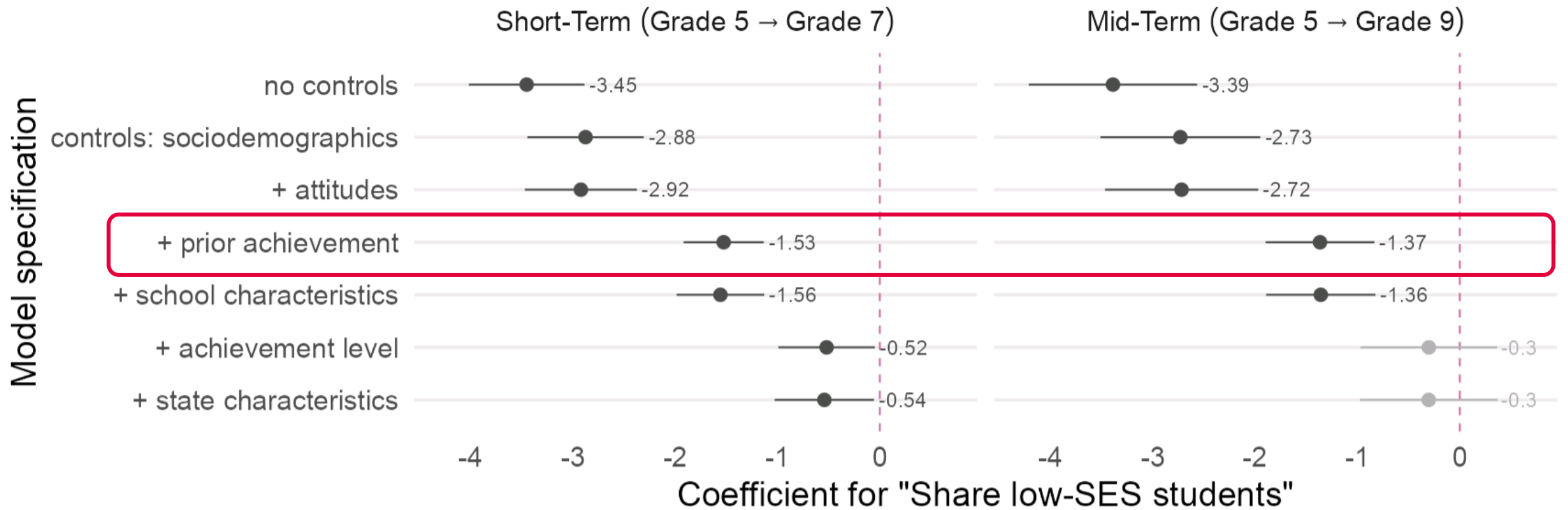


Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Secondary School Sample

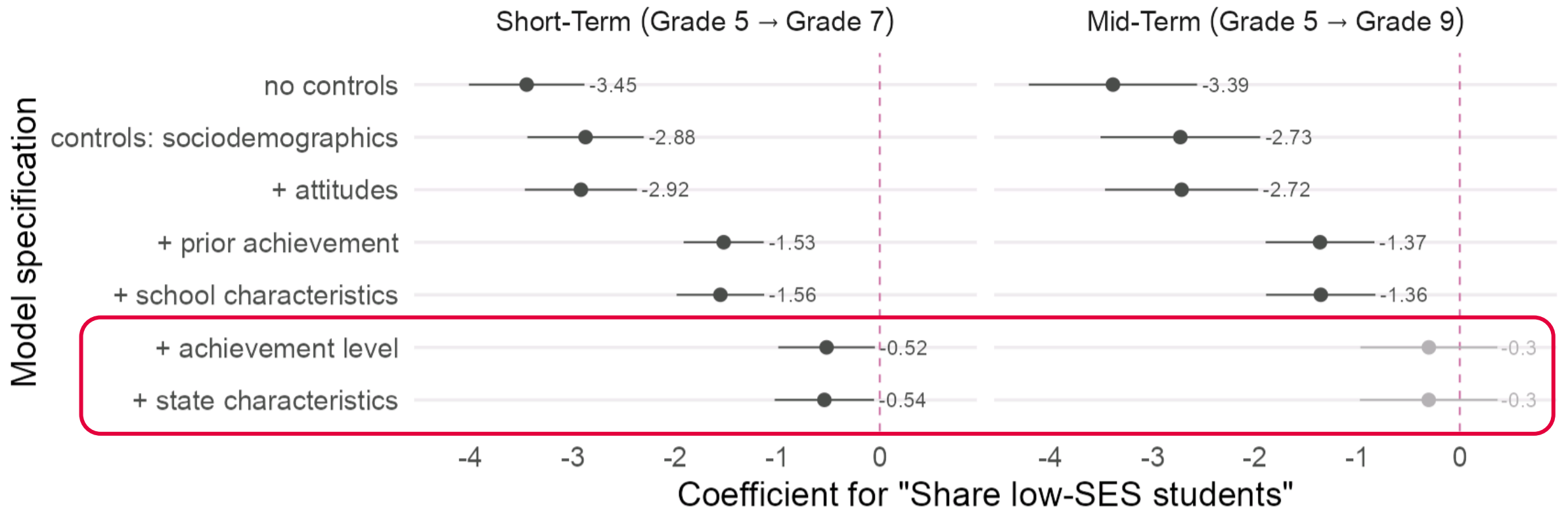


Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Secondary School Sample

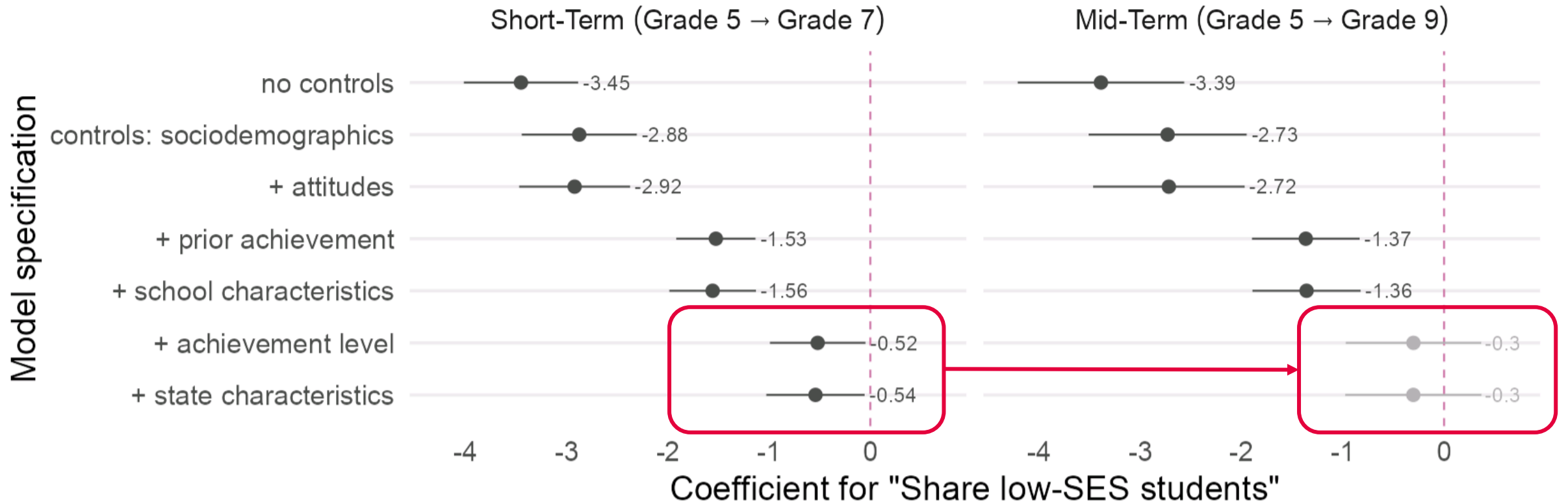


Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Regression Estimates

Effect of composition on competences

Regression Estimates for Secondary School Sample



Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

u^b Summary, Discussion & Outlook

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Summary

School composition affects students differently, depending on the educational stage

- Primary schools are socially and achievement-wise more homogeneous than secondary schools
- Initially, the composition effect is stronger in secondary schools than in primary schools
- Over time the effect increases in primary schools, whereas it decreases in secondary schools

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Open Questions

- Accumulation / perpetuation of composition effect due to tracked secondary school?
 - Panel attrition makes it difficult to analyze NEPS-data across transitions.
- Better understanding of the dilution of the composition effect in secondary school.
 - Overshadowed by increased heterogeneity due to grade repetition and track changes?

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Discussion

- Value-added specifications cancels out relevant aspects of school segregation
 - E.g., school composition can be a decisive factor when choosing a neighborhood (Rich & Owens, 2023)
 - Especially relevant for primary schools, with a close link between school and place of residence
- Similarly, tracking is not a mere “control variable”, but also a special form of social segregation producing socially distinct learning environments

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Thank you for your attention!
Questions?

u^b Appendix

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u^b Possible mechanisms

Peer Interaction

- Through norms and social contagion, students influence each other's achievement and motivation making them more similar
- In disadvantaged schools, this contributes to an adverse learning climate
 - Erbring & Young, 1979; Thrupp et al., 2002; Martin & Dowson, 2009; Goldsmith, 2011; Agirdag et al., 2012

School Resources

- More affluent schools tend to have more resources to promote an advantageous learning environment
- This includes building quality, material, but also the experience of teachers
 - Rumberger and Palardy 2005; Cebolla-Boado and Garrido Medina 2011; Teltemann and Schunck 2016; Papay & Kraft, 2015; Hanushek and Rivkin 2012; Baltussen et al., 2019; Hanselman, 2018, 2019; OECD, 2020

Instructional Quality

- Teachers adapt their instructional level based on perceptions of students' abilities and learning needs
- Teachers have (unjustifiably) low expectations of classrooms composed of many low-SES students
 - Rosenthal & Jacobson, 1968; Beckerman & Good, 1981; Jussim et al. 1996; Harker & Tymms, 2004; van den Bergh et al., 2010; Agirdag et al., 2013

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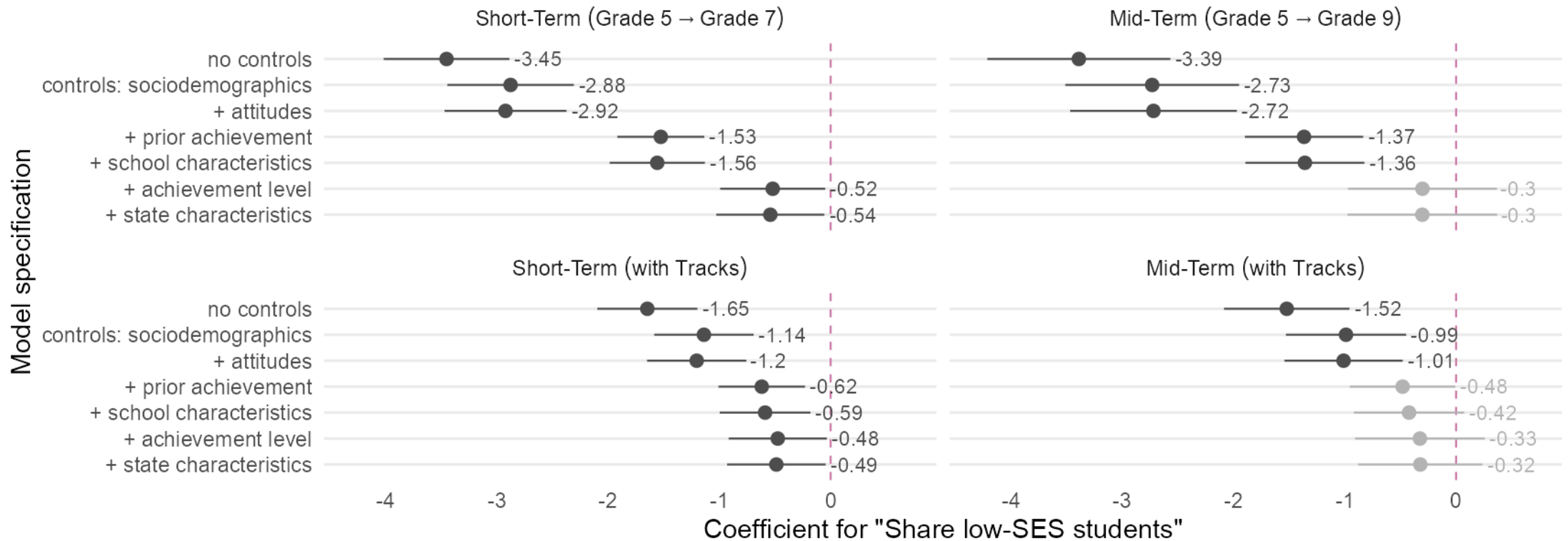
Analytical Samples

	Primary short-term (grade 1 → 2)	Primary mid-term (grade 1 → 4)	Secondary short-term (grade 5 → 7)	Secondary mid-term (grade 5 → 9)
$N_{students}$	5819	5458	3833	3116
$N_{schools}$	360	374	203	186
Students per school	16.2	14.6	18.9	16.8
Imputations	20	20	20	20
Source	NEPS, SC2	NEPS, SC2	NEPS, SC3	NEPS, SC3

u^b Regression Estimates

Effect of composition on competence

Regression Estimates for Secondary School Sample



Models fit with linear mixed-effect regression. Error bars show the 95% confidence interval.

	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	2.659*** (0.057)	2.603*** (0.060)	2.096*** (0.177)	0.913*** (0.130)	1.045*** (0.164)	1.239*** (0.194)	1.741*** (0.284)
share_lowses_lm	-2.065*** (0.251)	-1.159*** (0.239)	-1.162*** (0.267)	-0.284 (0.194)	-0.272 (0.185)	-0.403* (0.202)	-0.343+ (0.204)
ses_w3		0.322*** (0.022)	0.273*** (0.021)	0.053** (0.016)	0.053** (0.016)	0.052** (0.017)	0.051** (0.017)
female1		-0.355*** (0.030)	-0.393*** (0.029)	-0.161*** (0.023)	-0.160*** (0.023)	-0.158*** (0.023)	-0.160*** (0.023)
migrant.L		-0.079* (0.039)	-0.085* (0.038)	0.006 (0.032)	0.006 (0.032)	0.005 (0.032)	0.002 (0.032)
independence			0.493*** (0.039)	0.138*** (0.027)	0.137*** (0.027)	0.133*** (0.027)	0.132*** (0.027)
integration			-0.135*** (0.036)	-0.038 (0.027)	-0.039 (0.027)	-0.038 (0.027)	-0.038 (0.027)
enjoyment			0.050 (0.045)	0.001 (0.031)	0.002 (0.031)	0.002 (0.031)	0.004 (0.031)
PV_w3				0.849*** (0.018)	0.851*** (0.018)	0.860*** (0.018)	0.860*** (0.018)
competinginstitutions_w3					-0.001 (0.002)	-0.001 (0.002)	0.000 (0.002)
region_w32					-0.200*** (0.058)	-0.195*** (0.058)	-0.194*** (0.058)
region_w33					-0.056 (0.043)	-0.039 (0.043)	-0.017 (0.043)
condition_school_w3					-0.017 (0.032)	-0.008 (0.031)	-0.015 (0.031)
youngteacherratio					-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
math_w3_lm						-0.134* (0.057)	-0.135* (0.056)
east1							0.105 (0.071)
povertyquota							-0.025** (0.009)
privateschools							-0.016 (0.012)
Num.Obs.	5819	5819	5819	5819	5819	5819	5819
Num.Imp.	20	20	20	20	20	20	20

	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	5.056*** (0.073)	4.890*** (0.066)	4.305*** (0.172)	3.389*** (0.142)	3.628*** (0.173)	3.853*** (0.193)	3.602*** (0.297)
share_lowses_lm	-2.181*** (0.318)	-1.224*** (0.286)	-1.258*** (0.272)	-0.476* (0.215)	-0.493* (0.218)	-0.646** (0.240)	-0.585* (0.222)
ses_w3		0.336*** (0.022)	0.294*** (0.021)	0.118*** (0.017)	0.116*** (0.017)	0.116*** (0.017)	0.115*** (0.017)
female1		-0.130*** (0.031)	-0.171*** (0.031)	0.000 (0.027)	0.001 (0.027)	0.003 (0.027)	0.002 (0.027)
migrant.L		-0.047 (0.042)	-0.056 (0.041)	0.029 (0.037)	0.025 (0.037)	0.024 (0.037)	0.020 (0.037)
independence			0.401*** (0.036)	0.130*** (0.028)	0.128*** (0.028)	0.123*** (0.029)	0.122*** (0.029)
integration			-0.171*** (0.038)	-0.085* (0.034)	-0.086* (0.034)	-0.087* (0.034)	-0.086* (0.034)
enjoyment			0.148** (0.048)	0.092* (0.040)	0.095* (0.040)	0.095* (0.040)	0.097* (0.040)
PV_w3				0.663*** (0.019)	0.666*** (0.019)	0.675*** (0.021)	0.676*** (0.021)
competinginstitutions_w3					0.000 (0.002)	0.000 (0.002)	0.000 (0.002)
region_w32					-0.162* (0.064)	-0.150* (0.066)	-0.138* (0.066)
region_w33					-0.008 (0.044)	0.009 (0.045)	0.007 (0.044)
condition_school_w3					-0.067* (0.032)	-0.059+ (0.032)	-0.059+ (0.031)
youngteacherratio					-0.001 (0.001)	0.000 (0.001)	0.000 (0.001)
math_w3_lm						-0.148* (0.062)	-0.147* (0.059)
east1							-0.008 (0.076)
povertyquota							-0.007 (0.009)
privateschools							0.037** (0.013)
Num.Obs.	5458	5458	5458	5458	5458	5458	5458
Num.Imp.	20	20	20	20	20	20	20

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Secondary, short-term,
no tracks included

	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	1.308*** (0.072)	1.323*** (0.075)	1.398*** (0.153)	1.103*** (0.126)	1.093*** (0.200)	0.925*** (0.182)	0.804** (0.310)
share_lowses_lm	-3.451*** (0.288)	-2.875*** (0.290)	-2.921*** (0.280)	-1.526*** (0.199)	-1.558*** (0.218)	-0.520* (0.241)	-0.542* (0.248)
ses_w1		0.167*** (0.024)	0.161*** (0.024)	0.097*** (0.021)	0.094*** (0.021)	0.088*** (0.021)	0.088*** (0.021)
female1		-0.424*** (0.031)	-0.431*** (0.031)	-0.264*** (0.027)	-0.264*** (0.027)	-0.269*** (0.027)	-0.269*** (0.027)
migrant.L		-0.155*** (0.036)	-0.146*** (0.035)	-0.051 (0.032)	-0.058+ (0.032)	-0.065* (0.032)	-0.065* (0.032)
independence			0.262*** (0.043)	0.142** (0.040)	0.141** (0.040)	0.142** (0.040)	0.142** (0.040)
integration			-0.134*** (0.033)	-0.073* (0.033)	-0.074* (0.033)	-0.075* (0.033)	-0.076* (0.033)
enjoyment			-0.006 (0.034)	0.001 (0.030)	0.001 (0.030)	0.000 (0.029)	0.000 (0.029)
PV_w1				0.488*** (0.018)	0.487*** (0.019)	0.467*** (0.019)	0.466*** (0.019)
competinginstitutions_w1					0.004 (0.007)	0.009 (0.006)	0.009 (0.006)
region_w12					-0.013 (0.097)	-0.032 (0.076)	-0.030 (0.077)
region_w13					0.078 (0.065)	0.025 (0.055)	0.014 (0.056)
condition_school_w1					-0.022 (0.043)	-0.006 (0.037)	-0.008 (0.038)
youngteacherratio					0.002 (0.003)	0.000 (0.003)	0.000 (0.003)
math_w1_lm						0.388*** (0.050)	0.393*** (0.050)
east1							-0.086 (0.111)
povertyquota							0.010 (0.012)
privateschools							-0.001 (0.015)
Num.Obs.	3833	3833	3833	3833	3833	3833	3833
Num.Imp.	20	20	20	20	20	20	20

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	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	0.736*** (0.060)	0.759*** (0.063)	0.879*** (0.144)	0.828*** (0.127)	0.776*** (0.167)	0.776*** (0.167)	0.504+ (0.263)
share_lowses_lm	-1.647*** (0.229)	-1.138*** (0.228)	-1.203*** (0.228)	-0.619** (0.199)	-0.589** (0.208)	-0.475* (0.225)	-0.488* (0.226)
track.L	0.549*** (0.070)	0.546*** (0.065)	0.540*** (0.064)	0.371*** (0.052)	0.388*** (0.056)	0.356*** (0.060)	0.377*** (0.063)
track.Q	-0.818*** (0.071)	-0.804*** (0.067)	-0.799*** (0.066)	-0.427*** (0.052)	-0.437*** (0.055)	-0.381*** (0.064)	-0.383*** (0.068)
track.C	-0.545*** (0.052)	-0.504*** (0.048)	-0.485*** (0.048)	-0.269*** (0.038)	-0.273*** (0.038)	-0.236*** (0.047)	-0.239*** (0.050)
ses_w1		0.154*** (0.023)	0.149*** (0.023)	0.082*** (0.021)	0.083*** (0.020)	0.083*** (0.020)	0.082*** (0.020)
female1		-0.426*** (0.030)	-0.431*** (0.030)	-0.273*** (0.027)	-0.273*** (0.027)	-0.274*** (0.027)	-0.273*** (0.027)
migrant.L		-0.182*** (0.035)	-0.173*** (0.034)	-0.080* (0.031)	-0.076* (0.031)	-0.076* (0.032)	-0.078* (0.031)
independence			0.251*** (0.042)	0.137** (0.040)	0.137** (0.040)	0.138** (0.040)	0.138** (0.040)
integration			-0.131*** (0.033)	-0.075* (0.032)	-0.074* (0.032)	-0.075* (0.032)	-0.074* (0.033)
enjoyment			-0.014 (0.034)	-0.006 (0.029)	-0.006 (0.030)	-0.006 (0.029)	-0.006 (0.029)
PV_w1				0.466*** (0.019)	0.466*** (0.019)	0.462*** (0.019)	0.462*** (0.019)
competinginstitutions_w1					0.002 (0.005)	0.003 (0.005)	0.002 (0.005)
region_w12					-0.026 (0.068)	-0.028 (0.066)	-0.013 (0.067)
region_w13					-0.046 (0.050)	-0.046 (0.049)	-0.054 (0.049)
condition_school_w1					0.024 (0.033)	0.023 (0.032)	0.023 (0.033)
youngteacherratio					0.000 (0.002)	-0.001 (0.002)	-0.001 (0.003)
math_w1_lm						0.086 (0.060)	0.080 (0.063)
east1							-0.093 (0.106)
povertyquota							0.008 (0.010)
privateschools							0.020 (0.013)
Num.Obs.	3833	3833	3833	3833	3833	3833	3833
Num.Imp.	20	20	20	20	20	20	20

Secondary, short-term, tracks included

Secondary, mid-term,
no tracks included

	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	1.695*** (0.090)	1.698*** (0.089)	1.893*** (0.161)	1.520*** (0.137)	1.477*** (0.228)	1.363*** (0.205)	1.144** (0.376)
share_lowses_lm	-3.389*** (0.420)	-2.731*** (0.398)	-2.719*** (0.382)	-1.366*** (0.271)	-1.359*** (0.273)	-0.302 (0.341)	-0.304 (0.343)
ses_w1		0.202*** (0.021)	0.198*** (0.021)	0.144*** (0.019)	0.141*** (0.019)	0.134*** (0.019)	0.134*** (0.019)
female1		-0.384*** (0.034)	-0.390*** (0.034)	-0.244*** (0.031)	-0.244*** (0.031)	-0.253*** (0.031)	-0.252*** (0.031)
migrant.L		-0.105* (0.041)	-0.102* (0.043)	-0.028 (0.037)	-0.034 (0.037)	-0.035 (0.036)	-0.038 (0.036)
independence			0.255*** (0.037)	0.146*** (0.033)	0.145*** (0.033)	0.145*** (0.032)	0.144*** (0.033)
integration			-0.156*** (0.035)	-0.101** (0.032)	-0.102** (0.032)	-0.105*** (0.031)	-0.105*** (0.031)
enjoyment			-0.019 (0.032)	0.011 (0.030)	0.010 (0.030)	0.008 (0.030)	0.009 (0.030)
PV_w1				0.439*** (0.018)	0.439*** (0.018)	0.417*** (0.018)	0.418*** (0.018)
competinginstitutions_w1					0.012 (0.008)	0.016* (0.006)	0.016* (0.007)
region_w12					0.070 (0.106)	0.036 (0.094)	0.056 (0.093)
region_w13					0.041 (0.071)	-0.012 (0.059)	-0.027 (0.060)
condition_school_w1					-0.025 (0.057)	-0.021 (0.049)	-0.013 (0.051)
youngteacherratio					0.003 (0.003)	0.001 (0.003)	-0.001 (0.004)
math_w1_lm						0.384*** (0.067)	0.391*** (0.071)
east1							-0.206+ (0.116)
povertyquota							0.002 (0.014)
privateschools							0.027 (0.018)
Num.Obs.	3116	3116	3116	3116	3116	3116	3116
Num.Imp.	20	20	20	20	20	20	20

u^b

	share low-ses	soc.-dems.	attitudes	prior achvmt.	school char.	achvmt. level	combined + state char.
(Intercept)	1.115*** (0.067)	1.147*** (0.071)	1.401*** (0.147)	1.277*** (0.132)	1.281*** (0.189)	1.287*** (0.188)	0.823** (0.310)
share_lowses_lm	-1.522*** (0.288)	-0.989*** (0.276)	-1.011*** (0.271)	-0.481+ (0.242)	-0.423 (0.253)	-0.325 (0.297)	-0.322 (0.285)
track.L	0.449*** (0.086)	0.433*** (0.079)	0.424*** (0.082)	0.253*** (0.070)	0.263*** (0.074)	0.238** (0.074)	0.317*** (0.076)
track.Q	-0.742*** (0.075)	-0.713*** (0.071)	-0.703*** (0.071)	-0.347*** (0.066)	-0.347*** (0.066)	-0.300*** (0.076)	-0.311*** (0.077)
track.C	-0.624*** (0.055)	-0.570*** (0.052)	-0.553*** (0.051)	-0.368*** (0.045)	-0.369*** (0.045)	-0.337*** (0.054)	-0.343*** (0.053)
ses_w1		0.188*** (0.021)	0.183*** (0.021)	0.129*** (0.019)	0.129*** (0.019)	0.129*** (0.019)	0.129*** (0.019)
female1		-0.388*** (0.033)	-0.393*** (0.033)	-0.255*** (0.030)	-0.256*** (0.030)	-0.257*** (0.030)	-0.254*** (0.030)
migrant.L		-0.123** (0.040)	-0.119** (0.042)	-0.046 (0.036)	-0.044 (0.037)	-0.043 (0.036)	-0.048 (0.036)
independence			0.245*** (0.037)	0.142*** (0.033)	0.142*** (0.033)	0.142*** (0.032)	0.141*** (0.033)
integration			-0.156*** (0.034)	-0.105** (0.032)	-0.105** (0.032)	-0.105** (0.032)	-0.105** (0.032)
enjoyment			-0.028 (0.032)	0.001 (0.030)	0.001 (0.030)	0.001 (0.030)	0.003 (0.030)
PV_w1				0.414*** (0.018)	0.414*** (0.018)	0.412*** (0.018)	0.412*** (0.018)
competinginstitutions_w1					0.009 (0.006)	0.010+ (0.006)	0.009 (0.006)
region_w12					0.033 (0.082)	0.029 (0.081)	0.057 (0.078)
region_w13					-0.088+ (0.054)	-0.088+ (0.053)	-0.109* (0.051)
condition_school_w1					-0.008 (0.040)	-0.010 (0.040)	0.000 (0.039)
youngteacherratio					0.001 (0.003)	0.001 (0.003)	-0.001 (0.003)
math_w1_lm						0.073 (0.075)	0.050 (0.081)
east1							-0.206* (0.102)
povertyquota							0.002 (0.011)
privateschools							0.052*** (0.015)
Num.Obs.	3116	3116	3116	3116	3116	3116	3116
Num.Imp.	20	20	20	20	20	20	20

Secondary, mid-term,
tracks included

u^b

- Region

1. Intermediate
2. Rural
3. Urban

- Track

1. Hauptschule
2. Realschule
3. Gymnasium
4. Other