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Cross-national differences in social background effects on educational attainment and achievement: absolute vs. relative inequalities and the role of education systems

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Online Appendix to

“Cross-national differences in social background effects on educational attainment and achievement: Absolute vs. relative inequalities and the role of education systems”

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A Descriptive tables

Table A1. Country-specific means and proportions of individual-level variables

	Male	Age 30-34	Age 35-39	Age 40-44	Age 45-49	Parental Ed. low	Parental Ed. Med.	Parental Ed. hi	NBNL	NBFL	FBNL	FBFB	Years of educ.	Numeracy	Literacy
Austria	0.49	0.22	0.23	0.27	0.28	0.22	0.58	0.20	0.95	0.014	0.016	0.025	12.85	290.04	282.53
Belgium	0.49	0.22	0.22	0.26	0.30	0.36	0.37	0.27	0.95	0.035	0.01	0.0067	13.26	292.89	286.43
Canada	0.45	0.23	0.23	0.25	0.30	0.27	0.39	0.34	0.84	0.099	0.025	0.039	13.56	271.11	281.00
Chile	0.41	0.55	0.45	0.00	0.00	0.43	0.38	0.19	0.97	0.014	0.012	0.0022	12.46	218.60	230.18
Czech Republic	0.44	0.31	0.29	0.21	0.19	0.065	0.77	0.16	0.98	0.0015	0.0093	0.0046	13.75	281.79	281.11
Denmark	0.49	0.20	0.23	0.28	0.29	0.26	0.38	0.35	0.86	0.0082	0.019	0.11	13.65	293.47	284.01
Finland	0.49	0.26	0.22	0.23	0.28	0.33	0.48	0.19	0.96	0.019	0.017	0.006	13.66	299.85	306.46
France	0.49	0.22	0.24	0.26	0.28	0.42	0.39	0.19	0.91	0.028	0.027	0.035	12.67	272.16	275.44
Germany	0.50	0.22	0.21	0.28	0.30	0.058	0.54	0.40	0.93	0.014	0.017	0.039	14.11	288.62	284.41
Great Britain	0.41	0.24	0.25	0.25	0.26	0.31	0.46	0.23	0.93	0.013	0.031	0.023	12.84	271.63	282.58
Greece	0.44	0.22	0.25	0.27	0.26	0.67	0.22	0.11	0.94	0.0027	0.048	0.012	12.70	253.62	254.53
Ireland	0.46	0.26	0.27	0.27	0.20	0.51	0.29	0.20	0.90	0.009	0.075	0.015	15.52	266.01	275.78
Italy	0.51	0.19	0.27	0.28	0.26	0.70	0.23	0.065	0.95	0.024	0.02	0.0084	12.30	259.98	261.50
Japan	0.45	0.22	0.29	0.25	0.24	0.17	0.48	0.35	1.00	0.0009	0.0014	0.00	13.69	296.79	307.03
Korea	0.47	0.60	0.40	0.00	0.00	0.43	0.39	0.18	1.00	0.0019	0.00	0.0009	14.68	279.77	288.70
Netherlands	0.48	0.20	0.23	0.28	0.29	0.49	0.27	0.24	0.95	0.0053	0.021	0.028	13.94	294.98	298.43
New Zealand	0.40	0.23	0.25	0.27	0.25	0.35	0.27	0.38	0.85	0.029	0.066	0.053	13.98	280.50	291.24
Norway	0.51	0.23	0.24	0.26	0.27	0.21	0.42	0.37	0.93	0.011	0.011	0.05	15.02	299.33	296.70
Poland	0.49	0.27	0.26	0.22	0.25	0.24	0.63	0.13	0.99	0.013	0.00	0.0012	13.27	264.07	268.28
Spain	0.50	0.22	0.26	0.27	0.26	0.74	0.14	0.12	0.94	0.028	0.028	0.0043	12.00	257.41	262.92
Sweden	0.52	0.22	0.24	0.25	0.28	0.34	0.27	0.39	0.89	0.023	0.017	0.072	13.31	299.78	300.18
Turkey	0.53	0.30	0.28	0.23	0.19	0.89	0.073	0.042	0.97	0.034	0.0008	0.00	8.49	223.53	230.21
Unites States	0.45	0.36	0.21	0.21	0.21	0.12	0.48	0.40	0.89	0.033	0.032	0.045	13.68	260.49	277.60
Overall mean	0.47	0.25	0.25	0.24	0.25	0.37	0.38	0.25	0.92	0.03	0.024	0.027	13.25	274.01	278.75
Overall SD	0.50	0.43	0.43	0.43	0.43	0.48	0.49	0.43	0.27	0.17	0.15	0.16	3.12	49.67	44.62

Note: Ed.=Education; Med.=Intermediate; NB: Native-born; FB=Foreign-born; NL=Native-language; FL=Foreign-language.

Source: PIAAC, own calculations.

Table A2. Values of country-level predictors

	Tracking		Vocational orientation		% formal	% non-formal	Private School		Central Exit Examinations
	1963-1974	1975-1984	1963-1974	1975-1984	AET in past 12 months		1963-1974	1975-1984	
Austria	0.680	0.680	0.754	0.774	0.067	0.582	Med	Med	0.000
Belgium	0.500	0.500	0.487	0.676	0.081	0.542	Hi	Hi	0.000
Canada	0.000	0.000	0.000	0.000	0.146	0.602	Med	Med	0.510
Chile	n/a	0.417	n/a	0.420	0.171	0.485	n/a	Hi	0.000
Czech Republic	0.250	0.615	0.540	0.844	0.072	0.550	Low	Med	1.000
Denmark	0.280	0.280	0.653	0.541	0.151	0.706	Med	Med	1.000
Finland	0.250	0.250	0.531	0.522	0.187	0.729	Med	Med	1.000
France	0.167	0.250	0.580	0.534	0.052	0.432	Hi	Hi	1.000
Germany	0.692	0.692	0.789	0.765	0.063	0.605	Med	Med	0.440
Greece	0.280	0.280	0.328	0.293	0.052	0.192	Med	Med	0.000
Ireland	0.478	0.478	0.245	0.208	0.169	0.510	Hi	Low	1.000
Italy	0.385	0.385	0.680	0.724	0.058	0.300	Med	Med	1.000
Japan	0.280	0.250	0.293	0.277	0.032	0.463	Low	Med	1.000
Korea	n/a	0.429	n/a	0.432	0.046	0.573	n/a	Hi	1.000
Netherlands	0.440	0.360	0.521	0.704	0.149	0.673	Hi	Hi	1.000
New Zealand	0.000	0.000	0.215	0.380	0.218	0.674	Low	Med	1.000
Norway	0.250	0.231	0.567	0.552	0.186	0.693	Low	Med	1.000
Poland	0.360	0.360	0.746	0.703	0.067	0.376	Med	Med	1.000
Spain	0.360	0.167	0.416	0.398	0.131	0.491	Hi	Hi	0.000
Sweden	0.250	0.250	0.771	0.560	0.138	0.735	Low	Low	0.000
Turkey	0.500	0.500	0.407	0.436	0.135	0.219	Low	Low	1.000
GBR	0.154	0.154	0.443	0.579	0.174	0.546	Med	Hi	1.000
USA	0.000	0.000	0.000	0.000	0.180	0.567	Med	Med	0.090
Mean:	0.312	0.327	0.475	0.492	0.118	0.533			0.654
Std. Deviation:	0.195	0.198	0.232	0.230	0.057	0.151			0.459

Note: n/a: not available; AET=Adult Education and Training; Tracking is the percent of the total length of primary and secondary schooling that is tracked. Vocational orientation is the proportion of students in upper secondary education who are enrolled in a vocational programme. Tracking and vocational orientation measures for the 1963 to 1974 birth cohorts refer to the state of national education systems in the mid-1980s; the measures for the 1975 to 1984 cohorts refer to the state in the mid-1990s. AET shares are the proportion of adults aged 30 to 49 who participated in a formal/non-formal AET measure in the 12 months before the interview.

Sources: Tracking and vocational orientation measures are from Brunello and Checchi (2007, 799). AET shares were calculated by the authors from the PIAAC data. Prevalence of private school attendance in secondary education was calculated from enrolment numbers the OECD Education at a Glance database available at <https://stats.oecd.org/>. Private schools include both “independent” and “government-dependent” private schools. Categories were defined as follows: low = 0-5%; medium = 5-20%, high = > 20%. Data on central exit examinations are from version 4 of the educational systems data base by Bol and van de Werfhorst (see <http://thijsbol.com/data/>). Bol and van de Werfhorst gathered data from Eurydice (2004), Woessmann (2005), and Woessmann et al. (2009). For details, see Bol and van de Werfhorst (2016). Bol and van de Werfhorst data base provides no value for Chile, so we obtained that from Woessmann (2002).

Table A3. Pairwise correlations among the country-level predictors

	Tracking 1963-1974	Tracking 1975-1984	Vocational orientation 1963-1974 1974	Vocational orientation 1975-1984	% formal AET in past 12 months	% non-formal AET in past 12 months
Tracking 1975-1984	0.89***					
Vocational orientation 1963-1974	0.61**	0.63**				
Vocational orientation 1975-1984	0.58**	0.67***	0.89***			
% formal AET in past 12 months	-0.40	-0.47*	-0.32	-0.28		
% non-formal AET in past 12 months	-0.10	-0.10	0.18	0.18	0.53**	
Central exams	-0.15	-0.03	0.07	0.17	0.07	0.08

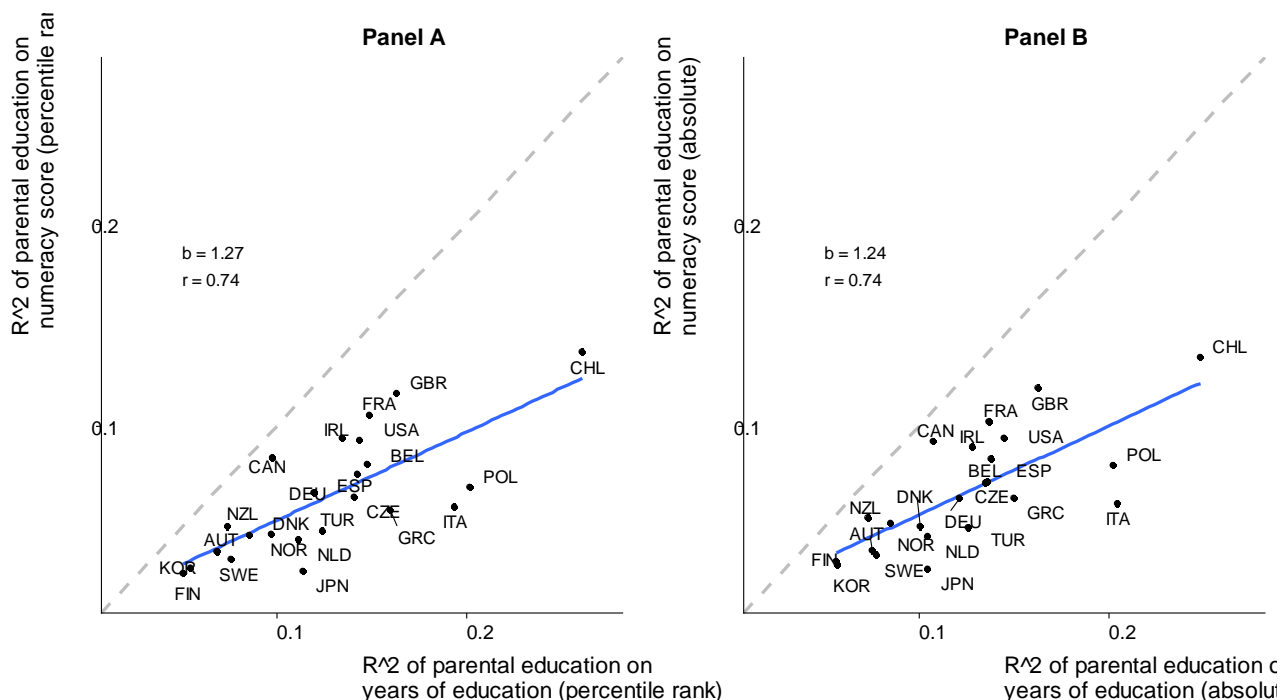
Note: See notes to Table A2 for sources and information about the variables.

*** $p < .001$; ** $p < .01$; * $p < .05$.

B Explained variance as an alternative measure of the association between parental background and educational success

A major focus of our analysis is to compare the association between parental background educational outcomes across different measures of educational success. In the main article (see Figure 1 in particular), we measure the association as the estimated (country-specific) coefficient on the parental background measure. Following the suggestion of an anonymous referee, we have also examined explained variance as an alternative measure of associational strength. More specifically, we calculated, for each country, the increase in R squared achieved by adding the parental background measure to a linear regression of the respective measure of educational success on the individual-level (control) variables sex, age, and foreign-birth/foreign-language status. This provides us with a measure of the additional variation explained by parental background, after accounting for the individual-level control variables. It is well-known that with such an approach the amount of variation attributed to parental background will depend on the order in which variables are introduced. That is, we would have obtained different (greater) contributions of parental background if we had chosen to introduce the parental background measure before some or even all of the control variables. The so-called Shapley decomposition accounts for these order effects by averaging contributions across all possible permutations (i.e., orders of introducing the different variables). Figure B1 shows the average increase in R squared, based on the Shapley decomposition of all the predictor variables.

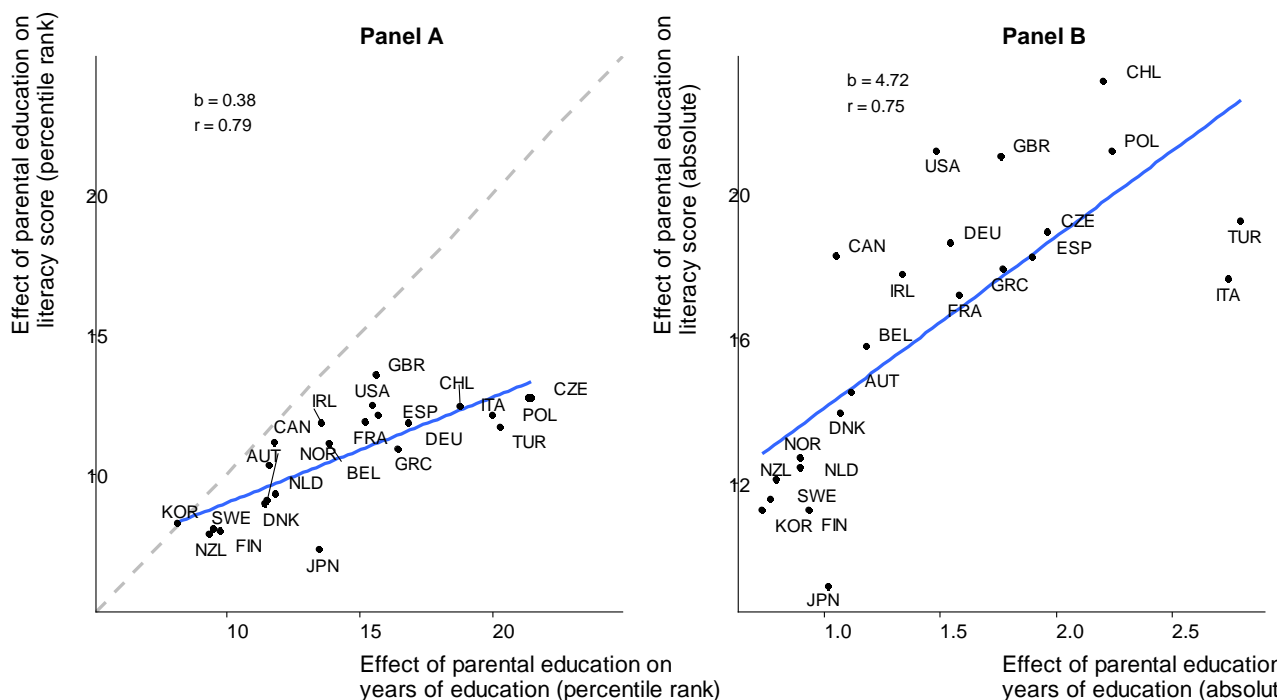
Figure B1. Increase in explained variance due to adding parental background to country-specific regressions of years of education and numeracy on sex, age, and foreign-birth/foreign-language status



Source: PIAAC, own calculations.

C Results for literacy

Figure C1. Social background effects on years of education (attainment) and literacy (achievement) in 23 countries



Countries codes: Austria (AUT), Belgium (BEL), Canada (CAN), Chile (CHL), Czech Republic (CZE), Denmark (DNK), Finland (FIN), France (FRA), Germany (GER), Great Britain (GBR), Greece (GRC), Ireland (IRL), Italy (ITA), Japan (JPN), Korea (KOR), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Poland (POL), Spain (ESP), Sweden (SWE), Turkey (TUR), USA (USA).
Source: PIAAC, own calculations.

Table C1. Regression results for literacy

	Percentile rank					Absolute score				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Parental education										
Main effect	10.77*** (0.50)	10.78*** (0.51)	10.78*** (0.51)	10.80*** (0.47)	10.84*** (0.48)	16.28*** (0.92)	16.28*** (0.93)	16.28*** (0.93)	16.24*** (0.82)	16.24*** (0.84)
Tracking										
Main effect		-0.19 (0.83)			-0.29 (1.03)		1.30 (1.96)			0.54 (2.17)
IA with parental educ.		0.51 (0.47)			0.51 (0.57)		-0.27 (0.68)			-0.01 (0.87)
Vocational orientation										
Main effect			-0.48 (0.82)		0.38 (1.00)			0.53 (1.92)		-0.74 (2.09)
IA with parental educ.			0.11 (0.45)		0.16 (0.53)			-0.06 (0.67)		0.20 (0.84)
AET participation (formal)										
Main effect				1.07 (0.93)	1.17 (1.12)				-8.01* (3.71)	-8.12+ (3.95)
IA with parental educ.				0.30 (0.55)	0.67 (0.64)				1.52 (0.98)	1.61 (1.11)
AET participation (non-formal)										
Main effect				-1.83+ (0.91)	-1.97+ (1.01)				17.38*** (3.70)	17.61*** (3.82)
IA with parental educ.				-1.25* (0.56)	-1.38* (0.60)				-2.60* (0.98)	-2.66* (1.04)
Var: cntry:cohort (Intercept)	10.37	10.66	10.30	10.71	10.43	6.30	6.55	6.58	6.29	6.81
Var: cntry:cohort pared	0.08	0.08	0.07	0.08	0.08	0.40	0.46	0.39	0.40	0.45
Cov: cntry:cohort (Intercept) pared	-0.90	-0.95	-0.88	-0.90	-0.92	-0.83	-1.10	-0.84	-0.80	-0.97
Var: cntry (Intercept)	8.97	9.71	9.66	7.23	8.89	430.34	444.41	430.89	220.97	228.60
Var: cntry pared	4.86	5.02	5.08	4.11	4.38	16.80	17.20	17.14	12.84	13.60
Cov: cntry (Intercept) pared	-3.53	-3.81	-3.73	-5.45	-6.24	-71.21	-72.89	-71.47	-40.60	-41.45
Var: Residual	766.58	766.56	766.58	766.56	766.56	1736.35	1736.37	1736.36	1736.35	1736.35

Notes: Coefficient estimates for individual-level controls have been omitted (available upon request). ***p < 0.001, **p < 0.01, *p < 0.05, +p < 0.1.
Source: PIAAC, own calculations.

D Country-level regressions: full results including coefficients of lower-level control variables

Table D1: Education systems and educational success, relative (percentile) measures of educational success, full results including control variables

	Percentile rank of years of education					Percentile rank of numeracy				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Intercept	38.70*** (1.19)	38.71*** (1.22)	38.69*** (1.20)	38.71*** (1.16)	38.75*** (1.21)	38.10*** (0.89)	38.11*** (0.91)	38.60*** (0.76)	38.14*** (0.88)	38.16*** (0.91)
Sex (ref.: female)										
Male	-2.58*** (0.23)	-2.58*** (0.23)	-2.58*** (0.23)	-2.58*** (0.23)	-2.58*** (0.23)	7.66*** (0.24)	7.66*** (0.24)	7.66*** (0.24)	7.67*** (0.24)	7.66*** (0.24)
Foreign-birth/-language status (ref.: native-born, native lang.)										
Native-born, foreign lang.	-1.56* (0.69)	-1.56* (0.69)	-1.56* (0.69)	-1.57* (0.69)	-1.54* (0.69)	-4.29*** (0.73)	-4.29*** (0.73)	-4.30*** (0.73)	-4.28*** (0.73)	-4.26*** (0.73)
Foreign-born, native lang.	4.69*** (0.76)	4.69*** (0.76)	4.68*** (0.76)	4.66*** (0.76)	4.65*** (0.76)	-0.08 (0.80)	-0.07 (0.80)	-0.08 (0.80)	-0.09 (0.80)	-0.08 (0.80)
Foreign-born, foreign lang.	6.15*** (0.71)	6.15*** (0.71)	6.15*** (0.71)	6.15*** (0.71)	6.14*** (0.71)	-9.89*** (0.75)	-9.88*** (0.75)	-9.87*** (0.75)	-9.87*** (0.75)	-9.87*** (0.75)
Age (ref.: 30-34)										
35-39	0.36 (0.34)	0.35 (0.34)	0.36 (0.34)	0.36 (0.34)	0.34 (0.34)	0.52 (0.35)	0.51 (0.36)	0.26 (0.36)	0.48 (0.36)	0.46 (0.36)
40-44	0.50 (0.55)	0.46 (0.55)	0.48 (0.55)	0.48 (0.55)	0.37 (0.56)	0.61 (0.53)	0.55 (0.54)	-0.56 (0.60)	0.45 (0.54)	0.35 (0.55)
45-49	-1.32* (0.55)	-1.37* (0.56)	-1.34* (0.55)	-1.34* (0.55)	-1.45** (0.56)	-1.86*** (0.53)	-1.91*** (0.54)	-3.05*** (0.61)	-2.01*** (0.54)	-2.11*** (0.55)
Parental education										
Main effect	14.49*** (0.87)	14.48*** (0.85)	14.51*** (0.86)	14.48*** (0.65)	14.50*** (0.62)	10.60*** (0.59)	10.60*** (0.60)	10.63*** (0.54)	10.61*** (0.52)	10.65*** (0.54)
Tracking										
Main effect		-0.54 (1.06)			-0.46 (1.26)		-0.05 (0.80)			0.11 (0.99)
IA with parental educ.		1.31* (0.64)			0.76 (0.63)		0.33 (0.53)			0.26 (0.60)
Vocational orientation										
Main effect			-1.16 (1.03)		0.06 (1.21)			-0.32 (0.69)		-0.12 (0.95)
IA with parental educ.			0.70 (0.58)		0.95 (0.58)			0.01 (0.45)		0.47 (0.56)
AET participation (formal)										
Main effect				1.73 (1.33)	1.56 (1.53)				0.78 (0.97)	0.80 (1.14)
IA with parental educ.				0.17 (0.77)	1.06 (0.80)				0.69 (0.62)	1.09 (0.71)
AET participation (non-formal)										
Main effect				-2.10 (1.31)	-2.10 (1.42)				-1.45 (0.96)	-1.43 (1.04)
IA with parental educ.				-2.98*** (0.77)	-3.39*** (0.76)				-1.75* (0.62)	-1.97** (0.66)
Var: cntry:cohort (Intercept)	6.66	7.31	6.53	6.69	7.62	3.93	4.18	18.08	4.35	4.82
Var: cntry:cohort pared	0.02	0.03	0.01	0.02	0.02	0.03	0.03	0.53	0.03	0.03
Cov: cntry:cohort (Intercept) pared	-0.39	-0.50	-0.31	-0.38	-0.37	-0.34	-0.36	-3.03	-0.36	-0.37
Var: cntry (Intercept)	25.81	27.11	26.47	24.37	26.19	12.63	13.25	0.00	12.05	13.01
Var: cntry pared	16.48	15.86	16.36	8.86	7.94	7.17	7.40	5.63	5.47	5.72
Cov: cntry (Intercept) pared	-7.15	-7.52	-6.87	-11.92	-13.24	-5.01	-5.31	0.00	-7.40	-8.20
Var: Residual	678.75	678.71	678.75	678.75	678.72	755.58	755.57	755.49	755.55	755.53

***p < 0.001, **p < 0.01, *p < 0.05, +p < 0.1

Source: PIAAC, own calculations.

Table D2: Education systems and educational success, absolute measures of educational success, full results including control variables

	Years of education					Numeracy				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Intercept	12.30*** (0.28)	12.30*** (0.28)	12.30*** (0.28)	12.31*** (0.23)	12.30*** (0.22)	256.37*** (4.99)	256.30*** (5.01)	256.30*** (4.96)	256.42*** (3.43)	256.37*** (3.47)
Sex (ref.: female)										
Male	-0.22*** (0.02)	-0.22*** (0.02)	-0.22*** (0.02)	-0.22*** (0.02)	-0.22*** (0.02)	12.57*** (0.45)	12.57*** (0.45)	12.57*** (0.45)	12.57*** (0.45)	12.57*** (0.45)
Foreign-birth/-language status (ref.: native-born, native lang.)										
Native-born, foreign lang.	-0.23** (0.07)	-0.23** (0.07)	-0.23** (0.07)	-0.23** (0.07)	-0.23** (0.07)	-10.19*** (1.51)	-10.19*** (1.51)	-10.18*** (1.51)	-10.20*** (1.51)	-10.19*** (1.51)
Foreign-born, native lang.	0.46*** (0.08)	0.47*** (0.08)	0.46*** (0.08)	0.46*** (0.08)	0.46*** (0.08)	-0.93 (1.49)	-0.92 (1.48)	-0.92 (1.49)	-0.92 (1.48)	-0.92 (1.48)
Foreign-born, foreign lang.	0.58*** (0.07)	0.58*** (0.07)	0.58*** (0.07)	0.57*** (0.07)	0.57*** (0.07)	-18.22*** (1.38)	-18.21*** (1.38)	-18.20*** (1.38)	-18.23*** (1.38)	-18.22*** (1.38)
Age (ref.: 30-34)										
35-39	-0.02 (0.03)	-0.02 (0.03)	-0.02 (0.03)	-0.02 (0.03)	-0.01 (0.03)	0.17 (0.64)	0.19 (0.64)	0.20 (0.64)	0.17 (0.64)	0.19 (0.64)
40-44	-0.11* (0.04)	-0.10* (0.04)	-0.11* (0.04)	-0.11* (0.04)	-0.10* (0.04)	-2.26* (0.87)	-2.21* (0.86)	-2.16* (0.89)	-2.23* (0.87)	-2.17* (0.89)
45-49	-0.31*** (0.04)	-0.30*** (0.05)	-0.31*** (0.05)	-0.31*** (0.04)	-0.30*** (0.05)	-6.71*** (0.82)	-6.67*** (0.82)	-6.62*** (0.84)	-6.69*** (0.82)	-6.64*** (0.84)
Parental education										
Main effect	1.47*** (0.13)	1.47*** (0.13)	1.47*** (0.13)	1.47*** (0.08)	1.47*** (0.07)	17.87*** (1.18)	17.89*** (1.20)	17.94*** (1.22)	17.83*** (0.95)	17.88*** (0.98)
Tracking										
Main effect		-0.28+ (0.15)			-0.13 (0.16)		0.69 (2.07)			-0.19 (2.31)
IA with parental educ.		0.26** (0.09)			0.17* (0.08)		0.30 (0.78)			0.26 (1.00)
Vocational orientation										
Main effect			-0.04 (0.15)		-0.15 (0.15)			0.72 (2.09)		0.02 (2.30)
IA with parental educ.			0.06 (0.09)		0.10 (0.08)			0.53 (0.75)		0.67 (0.95)
AET participation (formal)										
Main effect				-0.26 (0.27)	-0.40 (0.28)				-12.20** (3.99)	-12.27** (4.22)
IA with parental educ.				0.14 (0.10)	0.28** (0.10)				2.45* (1.12)	2.95* (1.26)
AET participation (non-formal)										
Main effect				0.94*** (0.27)	0.99*** (0.27)				20.54*** (3.98)	20.53*** (4.10)
IA with parental educ.				-0.57*** (0.10)	-0.62*** (0.09)				-4.05** (1.12)	-4.33** (1.20)
Var: cntry:cohort (Intercept)	0.06	0.06	0.06	0.06	0.06	9.09	9.67	9.47	8.95	9.62
Var: cntry:cohort pared	0.01	0.01	0.02	0.01	0.01	0.95	1.06	1.00	0.88	0.91
Cov: cntry:cohort (Intercept) pared	-0.03	-0.02	-0.03	-0.03	-0.03	-2.75	-3.06	-2.79	-2.63	-2.74
Var: cntry (Intercept)	1.77	1.77	1.78	1.16	1.10	557.08	560.34	550.63	255.32	261.02
Var: cntry pared	0.40	0.39	0.39	0.14	0.11	28.27	29.04	30.43	17.25	18.42
Cov: cntry (Intercept) pared	-0.66	-0.65	-0.66	-0.24	-0.20	-113.47	-114.72	-118.87	-54.00	-57.30
Var: Residual	6.79	6.79	6.79	6.79	6.79	2138.13	2138.10	2138.13	2138.13	2138.13

***p < 0.001, **p < 0.01, *p < 0.05, +p < 0.1.

Source: PIAAC, own calculations.

E Country-level regressions: additional specifications including private school attendance and central exit examinations

Table E1 presents additional regressions that include measures of private school attendance and the prevalence of central exit examinations as further potentially important characteristics of educational systems. For details on how these measures are constructed, see Table A2.

Overall, private school attendance and central exit exams are only weakly related to the strength of social background effects. Only for educational attainment do we find some evidence that the association between parental education and educational attainment is weaker when the prevalence of private schools is low. Importantly, the main results from Tables 1 and 2 in the main article above continue to hold when we add private school attendance and the centralization of exit exams (see Models 4, 8, 12, and 16 in Table E1). We still find that tracking is associated with stronger social background effects on educational attainment, particularly when the latter is measured in absolute terms (see Model 4 in Table E1 and Model 5 in Table 2 in the Main article). Higher prevalence of formal AET still seems to go hand in hand with stronger background effects on (absolute levels of) educational attainment and achievement (see Models 4 and 12 in Table E1 and Models 5 and 10 in Table 2 in the main article). Finally, we still find lower inequalities in achievement in countries with a greater prevalence of non-formal AET for all educational outcomes (see Models 4, 8, 12, and 16 in Table E1 and Models 5 and 10 in Tables 1 and 2 in the main article).

Table E1. Regressions including private school attendance and central exit examinations

	Years of education				Percentile rank Years of Education				Numeracy				Percentile rank of Numeracy			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
Parental education																
Main effect	1.46***	1.55***	1.52***	1.45***	14.49***	15.28***	15.15***	14.87***	18.57***	17.82***	18.39***	18.36***	10.77***	10.58***	10.66***	10.75***
	(0.24)	(0.16)	(0.26)	(0.16)	(1.57)	(1.07)	(1.70)	(1.29)	(2.13)	(1.49)	(2.30)	(1.99)	(1.07)	(0.82)	(1.19)	(1.10)
Tracking																
Main effect				-0.15				-0.61				0.20				-0.06
				(0.17)				(1.28)				(2.27)				(0.99)
IA with parental educ.				0.19*				0.81				0.35				0.27
				(0.08)				(0.66)				(1.02)				(0.61)
Vocational orientation																
Main effect				-0.08				0.50				1.25				0.15
				(0.17)				(1.25)				(2.31)				(0.97)
IA with parental educ.				0.05				0.71				0.27				0.34
				(0.08)				(0.62)				(0.98)				(0.58)
AET participation (formal)																
Main effect				-0.40				1.51				-12.09**				0.70
				(0.29)				(1.57)				(4.09)				(1.14)
IA with parental educ.				0.27**				1.02				2.93*				1.11
				(0.10)				(0.86)				(1.27)				(0.72)
AET participation (non-formal)																
Main effect				0.98***				-2.14				20.22***				-1.45
				(0.28)				(1.45)				(3.96)				(1.04)
IA with parental educ.				-0.61***				-3.33***				-4.25**				-1.93*
				(0.10)				(0.81)				(1.20)				(0.68)
Central exams																
Main effect	0.52		0.47	0.43	0.19		-0.08	-0.36	10.60		9.92	9.17	0.35		0.13	0.18
	(0.63)		(0.64)	(0.52)	(2.63)		(2.58)	(2.72)	(11.08)		(11.12)	(7.49)	(1.90)		(1.87)	(1.95)
IA with parental educ.	0.01		0.04	0.08	0.00		0.23	0.33	-1.05		-0.81	-0.76	-0.26		-0.13	-0.11
	(0.31)		(0.31)	(0.18)	(1.98)		(2.03)	(1.50)	(2.68)		(2.68)	(2.25)	(1.35)		(1.35)	(1.24)
Private schools																
Low (< 5%)		0.32	0.32	0.23		1.70	1.74	1.99		4.79	4.78	6.23+		1.21	1.20	0.35
		(0.26)	(0.26)	(0.26)		(2.25)	(2.29)	(2.11)		(3.48)	(3.49)	(3.57)		(1.76)	(1.80)	(1.68)
Med (5-20%)		0.07	0.07	-0.03		-1.73	-1.67	-1.08		-0.21	-0.27	0.32		-1.86	-1.85	-2.40
		(0.26)	(0.26)	(0.25)		(2.04)	(2.08)	(1.87)		(3.40)	(3.41)	(3.34)		(1.57)	(1.60)	(1.47)
Low, IA with parental educ.		-0.23	-0.23+	-0.17		-1.66+	-1.69+	-1.25		-1.48	-1.57	-1.64		-0.81	-0.79	-0.87
		(0.14)	(0.14)	(0.12)		(0.96)	(0.96)	(0.95)		(1.54)	(1.56)	(1.62)		(0.92)	(0.94)	(0.93)
Med, IA with parental educ.		-0.06	-0.07	-0.01		-0.91	-0.94	-0.65		0.72	0.69	0.71		0.39	0.40	0.31
		(0.14)	(0.14)	(0.12)		(0.92)	(0.93)	(0.88)		(1.41)	(1.42)	(1.47)		(0.86)	(0.87)	(0.85)

Var: cntry:cohort (Intercept)	0.06	0.06	0.06	0.06	6.62	7.54	7.56	7.69	9.09	7.52	7.50	7.69	3.93	4.89	4.93	5.20
Var: cntry:cohort pared	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.96	0.58	0.59	0.63	0.03	0.02	0.02	0.02
Cov: cntry:cohort (Intercept) pared	-0.03	-0.02	-0.02	-0.02	-0.39	-0.34	-0.33	-0.37	-2.77	-1.84	-1.84	-1.96	-0.34	-0.34	-0.34	-0.35
Var: cntry (Intercept)	1.79	1.83	1.87	1.19	27.33	23.85	25.35	27.35	558.48	556.65	562.21	243.94	13.35	11.39	12.12	12.75
Var: cntry pared	0.42	0.40	0.43	0.13	17.43	17.29	18.23	9.29	29.56	28.34	29.76	18.88	7.55	7.13	7.54	5.97
Cov: cntry (Intercept) pared	-0.69	-0.68	-0.72	-0.25	-7.57	-7.40	-7.88	-14.69	-116.59	-113.25	-117.22	-55.82	-5.29	-4.85	-5.14	-8.53
Var: Residual	6.79	6.79	6.79	6.79	678.75	678.69	678.69	678.69	2138.13	2138.13	2138.13	2138.13	755.58	755.53	755.53	755.51

***p < 0.001; **p < 0.01; *p < 0.05; +p < 0.1

Source: PIAAC, own calculations.

F Influence statistics (DFBETAs and Cook's D)

To assess the robustness of the estimated contextual effects, particularly of the interactions between the education system measures and parental education, we investigated how the estimated coefficients change when we drop one country (i.e., all cohorts from a given country) at a time. We focus on results for the models that include both the tracking and the vocational orientation measure (i.e., models 5 and 10 in Tables 1 and 2). We use the well-known DFBETA and Cook's D statistics to quantify the influence of a given country on the coefficient estimates. Intuitively, *DFBETA* indicates by how much the inclusion of country j changes the estimate for a coefficient of interest, say $\hat{\gamma}_i$, measured in multiples of the associated standard error estimate for the reduced sample. Formally,

$$DFBETA_{ij} = \frac{\hat{\gamma}_i - \hat{\gamma}_{i(-j)}}{se(\hat{\gamma}_{i(-j)})},$$

where $\hat{\gamma}_{i(-j)}$ denotes the coefficient estimate with country j omitted from the sample (see, for example, Nieuwenhuis, te Groitenhuis, and Pelzer 2012, 40). Positive values of *DFBETA* thus indicate that the inclusion of case j moves the coefficient estimate upward and negative values that its inclusion moves the estimate downward. Cook's D follows a very similar logic, but seeks to quantify the overall impact of an observation on a set of coefficients in one summary measure (for details, Nieuwenhuis, te Groitenhuis, and Pelzer 2012, 40). We ignore the lower-level control variables when calculating Cook's D. That is, our measure is based on the (contextual) coefficients of interest that we also show DFBETAs for: the main effects of parental education and the education system variables as well as the cross-level interactions between the latter and parental education.

Figures F1 to F4 display the DFBETA and Cook's D for the four different outcome measures considered in the main analysis. Results for numeracy (Figures F2 and F4) are based on the first plausible value to limit the computational burden. Dashed horizontal lines indicate a first set of threshold values for considering a case as influential. For DFBETA the thresholds are $\pm 2/\sqrt{n}$ and for Cook's D (which will always be greater than or equal to zero) it is $4/n$ (Nieuwenhuis, te Groitenhuis, and Pelzer 2012, 40f.). In the present case, where the relevant n is the size of the country-level sample, these rules imply cut-off of $\pm 2/\sqrt{23} \approx .417$ and $4/23 \approx .174$, respectively. These cut-offs are rather conservative and many sources give much higher values. Solid lines therefore indicate a second set of widely used cut-offs: ± 1 for DFBETA and 1 for Cook's D.

Overall, the results presented in Figures F1 to F4 are reassuring. In particular, there are only very few cases where one of the influence statistics exceeds the value of ± 1 . Moreover, there are only two case where this threshold is exceeded for one of the interaction terms between an education system characteristic and parental education, which are the effects of primary interest in our analysis. The first case is Greece and the interaction between non-formal AET participation and parental education (see the left graph in the bottom row in Figure F3). The DFBETA statistic indicates that the inclusion of Greece draws the coefficient estimate substantially upwards, by

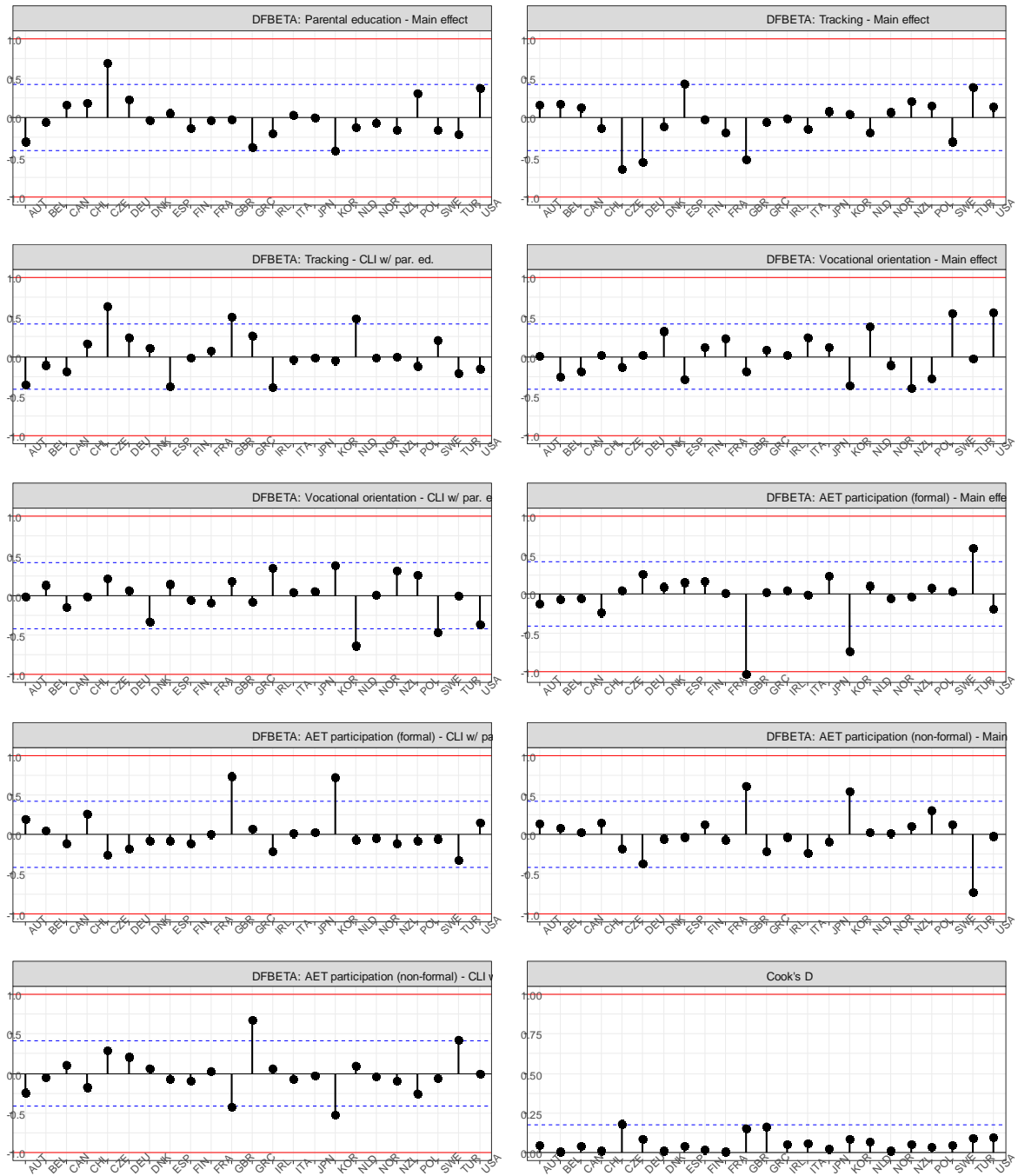
approximately one standard error, relative to the coefficient estimate in a reduced sample that omits Greece. Importantly, the coefficient estimate for the full sample in the main article is statistically significant and substantially negative (see Model 5 in Table 2). The outlier analysis presented here does not call this result into question. It rather indicates that the estimate in the main article may even be somewhat conservative (the point estimate would be even “more negative” if Greece, which draws it in in the positive direction, were omitted from the sample). The second case is Ireland and the interaction between tracking and parental education (see the left graph in the second row of Figure F3). The inclusion of the Irish case in this regression reduces the coefficient estimate substantially. Even so, the coefficient estimate remains positive and statistically significant in the main analysis (see Table 2 in the main article), which is consistent with the inequality-enhancing effect of tracking found in many previous studies. The inclusion of Ireland thus leads to a more conservative estimate.

Continuing with the influence statistics for the various interaction terms between the education system measures and parental education, there are a few cases where the DFBETA statistics exceed the more conservative cut-offs indicated by the dashed lines. In most cases, distribution of DFBETA statistics looks relatively well-balanced, however, meaning that country cases that draw the estimated interaction effect substantially in the upward direction are counterbalanced by other country cases that draw it substantially in the downward direction. A good example of this pattern is the interaction between tracking and parental education in the model for the years of education percentile rank (left graph in the second row in Figure F1), where the “positive” impact of the Czech Republic, Great Britain, and the Netherlands is more or less neutralised by the “negative” impact of Spain, Austria, and Ireland.

Our overall interpretation of the results is that our qualitative conclusions concerning the interactions between the education system measures and parental background do not hinge on the inclusion of single country cases.

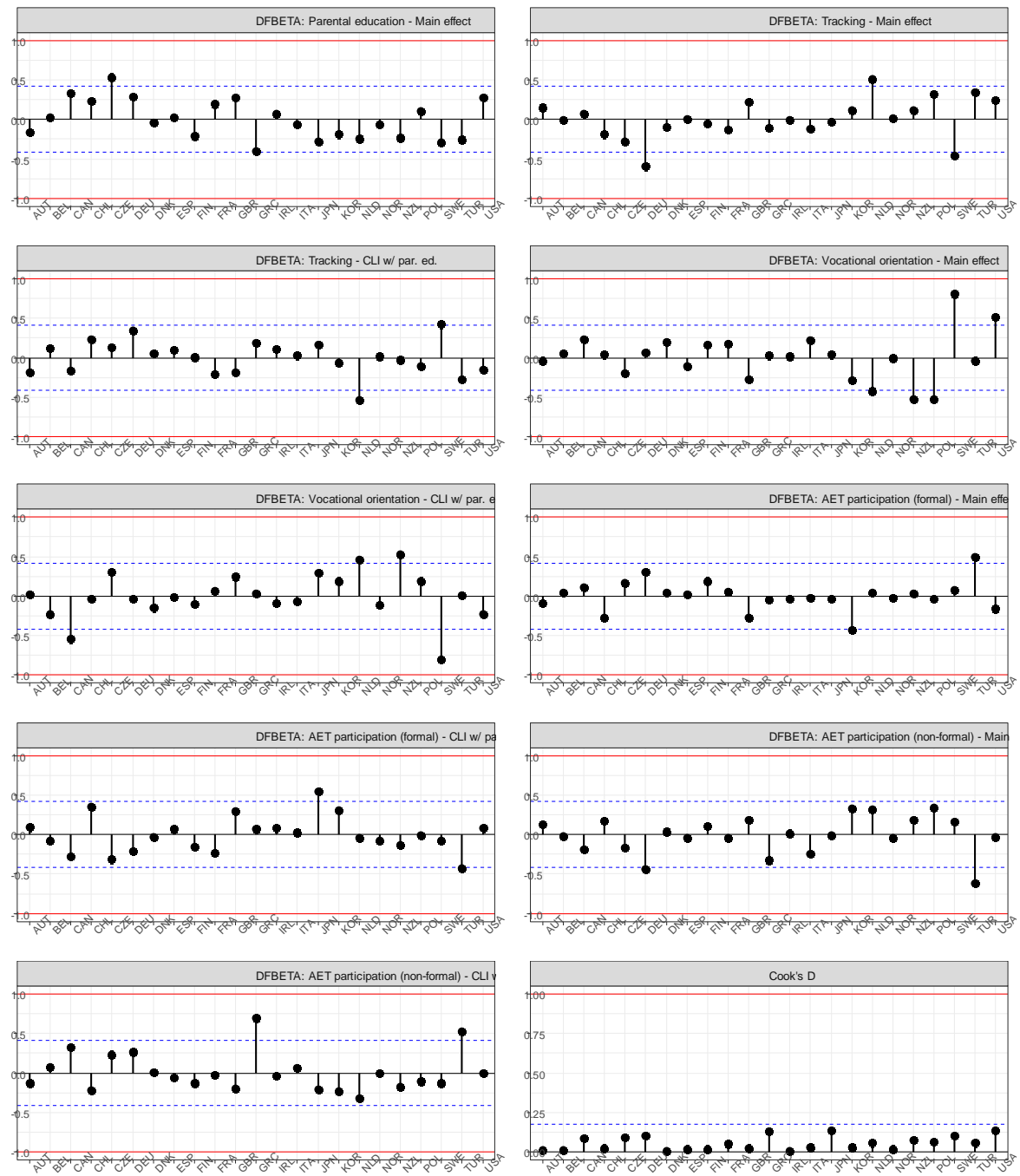
The DFBETA statistics for the main effects of the education system measure give somewhat greater reason for concern in several cases. Fortunately, these main effects are only of limited relevance for our main research questions. These coefficients capture the institutional “effects” on the outcomes among adults with a low parental education (who have a score of zero on the parental education measure), but our main interest lies with inequalities by social background. We nevertheless highlight two examples. The first is the main effect of tracking in the model for years of education (absolute; see right graph in the first row in Figure F3). This coefficient estimate drawn upwards by more than standard error due to the inclusion of Ireland and there is no other country that would have a comparably strong negative impact on the estimate. A second example is the main effect of formal AET participation in the model for numeracy (see right graph in the third row in Figure F4). This coefficient estimate was surprisingly large and negative in the main analysis, implying that numeracy skills tend to be lower in countries with higher levels of formal AET (see Model 10 in Table 2). The DFBETA statistics in Figure F4 indicate that this counterintuitive result is driven to a substantial extent by the influential case of Chile.

Figure F1. Influence statistics for context effects, Model 5 in Table 1 (years of education, percentile rank)



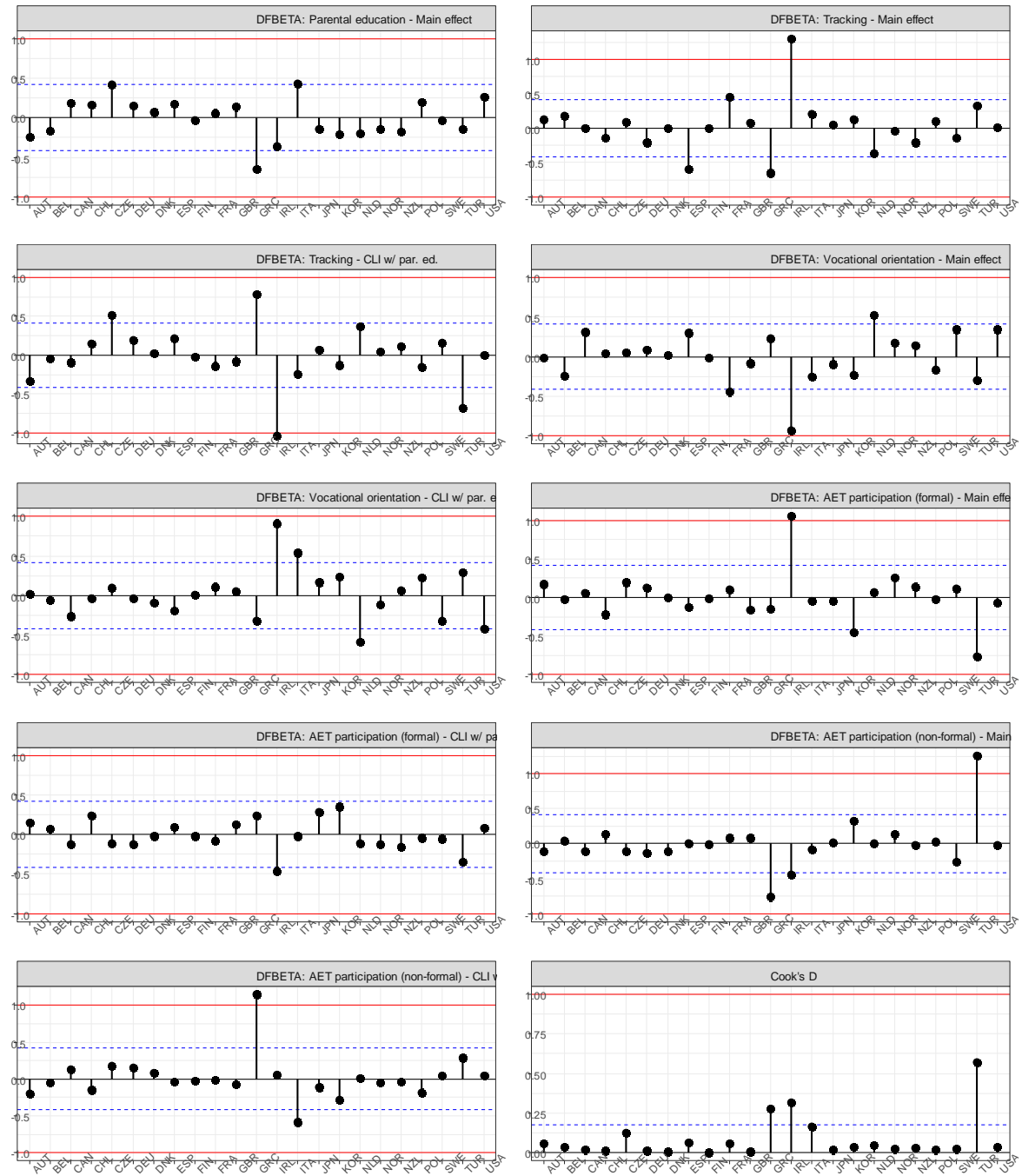
Dashed lines indicate conservative (low) cut-off values for high influence, which are equal to $\pm \frac{2}{\sqrt{n}}$ for DFBETA and $\frac{4}{n}$ for Cook's D (with $n=23$, the number of countries in the full sample). Solid lines indicate more generous cut-offs of ± 1 and 1 for DFBETA and Cook's D , respectively. Lower-level controls were not included in the calculation of Cook's D (i.e., only the coefficients for which DFBETAs are shown were used).

Figure F2. Influence statistics for context effects, Model 10 in Table 1 (numeracy, percentile rank)



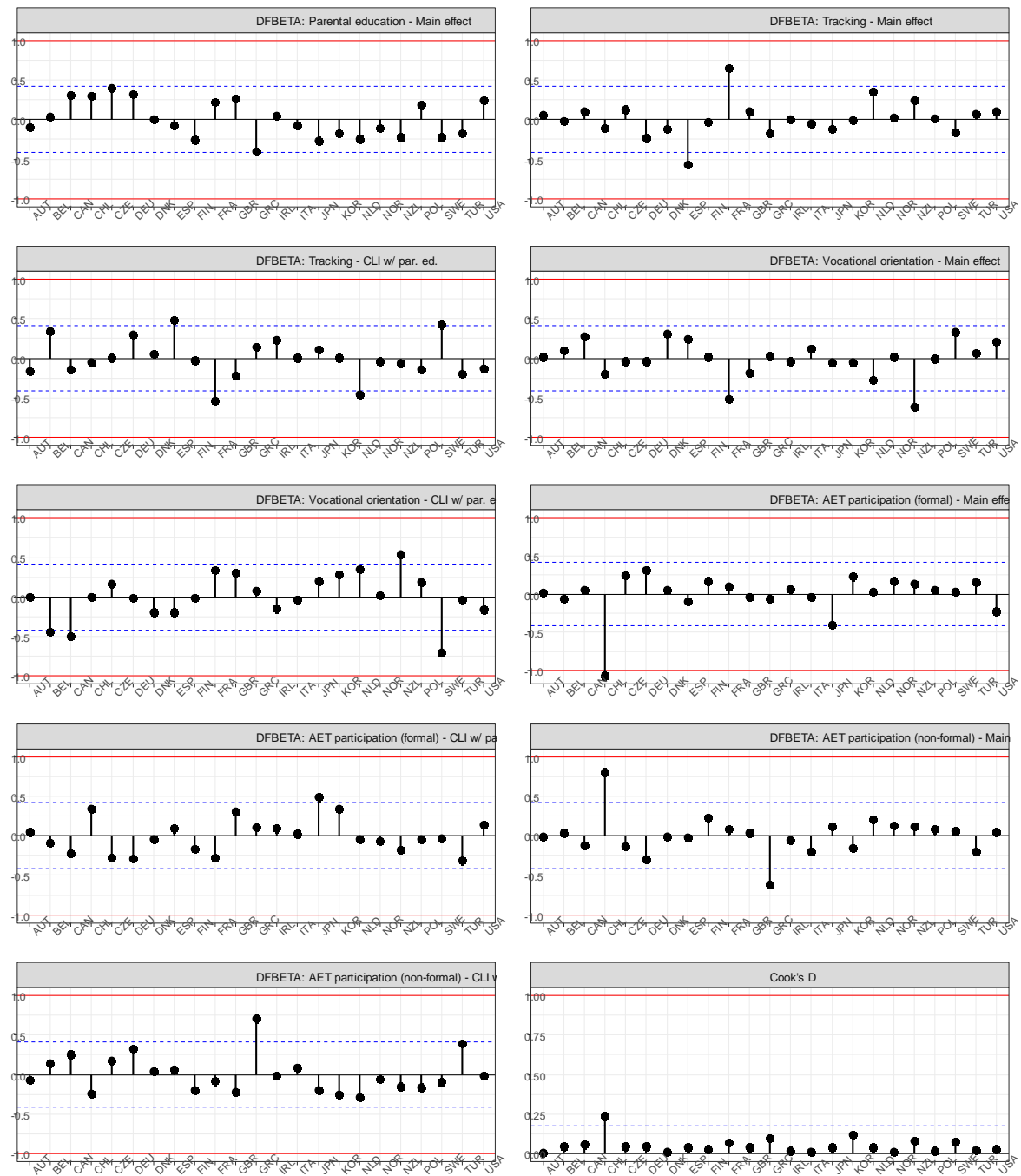
Dashed lines indicate conservative (low) cut-off values for high influence, which are equal to $\pm 2/\sqrt{n}$ for DFBETA and $4/n$ for Cook's D (with $n=23$, the number of countries in the full sample). Solid lines indicate more generous cut-offs of ± 1 and 1 for DFBETA and Cook's D , respectively. Lower-level controls were not included in the calculation of Cook's D (i.e., only the coefficients for which DFBETAs are shown were used).

Figure F3. Influence statistics for context effects, Model 5 in Table 2 (years of education, absolute score)



Dashed lines indicate conservative (low) cut-off values for high influence, which are equal to $\pm \frac{2}{\sqrt{n}}$ for DFBETA and $\frac{4}{n}$ for Cook's D (with $n=23$, the number of countries in the full sample). Solid lines indicate more generous cut-offs of ± 1 and 1 for DFBETA and Cook's D , respectively. Lower-level controls were not included in the calculation of Cook's D (i.e., only the coefficients for which DFBETAs are shown were used).

Figure F4. Influence statistics for context effects, Model 10 in Table 2 (numeracy, absolute score)



Dashed lines indicate conservative (low) cut-off values for high influence, which are equal to $\pm \frac{2}{\sqrt{n}}$ for DFBETA and $\frac{4}{n}$ for Cook's D (with $n=23$, the number of countries in the full sample). Solid lines indicate more generous cut-offs of ± 1 and 1 for DFBETA and Cook's D , respectively. Lower-level controls were not included in the calculation of Cook's D (i.e., only the coefficients for which DFBETAs are shown were used).

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