Supplementary Material S4: R Analyses Added in Revision

Output of the revision analyses run in RStudio on 2026-10-26, read from the result files in `revision/` (R 4.5.2; grf 2.6.1). Random seed for all forests: 20260923. All numbers below are read directly from the saved `.rds` outputs.

1. Scripts and order

- `08_ortak.R`
- `09a_yanitsizlik_betimsel.R`
- `09b_yanitsizlik_orman.R`
- `10_regfun.R`
- `10a_anket_tasarimi.R`
- `10b_ulke_duzeyi.R`
- `10c_okul_ps.R`
- `11_h4_kontrast.R`
- `12_orman_esit_ulke.R`
- `13_esdegerlik.R`

2. Respondents and non-respondents, 2025 (a1_yanitsizlik_betimsel)

ulke

CNT	n	nr	nr_prog1	nr_prog0	fark_1m0
ALB	4954	0.04103	0.03444	0.05971	-0.02527
ARG	7809	0.2527	0.1744	0.3076	-0.1333
AUT	6233	0.09556	0.08697	0.1204	-0.03342
BGR	4884	0.2155	0.2152	0.216	-0.0007355
BRA	2.497e+04	0.1621	0.1534	0.1678	-0.0144
BRN	5404	0.114	0.1102	0.1283	-0.0181
CHE	5772	0.1683	0.1837	0.1308	0.05298
CHL	4903	0.194	0.2245	0.179	0.04552
COL	6444	0.1009	0.1038	0.09831	0.005514
CZE	7828	0.07758	0.08384	0.07281	0.01102
DEU	4632	0.1337	0.1226	0.1759	-0.0533
DOM	5275	0.1828	0.1999	0.1418	0.05815
ESP	2.668e+04	0.0879	0.08898	0.08587	0.003112
EST	5907	0.0364	0.029	0.04373	-0.01474
FIN	7041	0.05622	0.05595	0.05665	-0.0006924
FRA	4012	0.1405	0.1358	0.1535	-0.01777
GEO	5326	0.139	0.132	0.1458	-0.01376
GRC	6330	0.07045	0.07273	0.06807	0.004655
HKG	5530	0.02882	0.0277	0.03737	-0.009675
HRV	5901	0.07717	0.07215	0.08144	-0.00929
HUN	5264	0.02538	0.01714	0.03782	-0.02068
IDN	1.348e+04	0.04609	0.04553	0.04783	-0.002309
IRL	5693	0.03346	0.03357	0.03267	0.0008946
ITA	8230	0.05153	0.05024	0.05448	-0.004237
JOR	7060	0.1308	0.1245	0.1775	-0.05296
JPN	6170	0.01883	0.02012	0.01653	0.003595
KAZ	2.065e+04	0.0808	0.08177	0.07844	0.003339
KOR	6324	0.00928	0.009115	0.009703	-0.0005876

KSV	4996	0.2143	0.2206	0.2082	0.01245
LBN	4171	0.3727	0.36	0.3894	-0.02939
LTU	6610	0.06701	0.06861	0.06498	0.003624
LVA	5312	0.06727	0.07765	0.06317	0.01448
MAR	5872	0.1615	0.1482	0.1785	-0.03034
MDA	5899	0.08874	0.08877	0.0887	6.686e-05
MEX	7561	0.07695	0.07105	0.08347	-0.01242
MKD	5140	0.1388	0.1527	0.1208	0.03187
MNE	5615	0.1129	0.1079	0.1159	-0.008015
MYS	7210	0.02971	0.02591	0.0398	-0.01389
NLD	2840	0.1323	0.1074	0.1632	-0.05576
PER	6359	0.2274	0.2309	0.2231	0.007878
PHL	7704	0.04823	0.04609	0.05875	-0.01266
POL	6628	0.06414	0.06977	0.05892	0.01084
PRT	6376	0.06608	0.06734	0.06232	0.005017
ROU	7171	0.08701	0.08246	0.09103	-0.008565
SAU	6189	0.1186	0.1162	0.1339	-0.01769
SRB	5999	0.1267	0.1141	0.1342	-0.02012
SVK	5968	0.07542	0.08099	0.06959	0.01139
SVN	6124	0.07415	0.0826	0.06425	0.01835
TAP	6541	0.01407	0.01494	0.0116	0.003339
THA	7683	0.04099	0.03857	0.04538	-0.006806
URY	5981	0.2354	0.2698	0.2131	0.05671

yuksek25

`[1] "ARG" "BGR" "KSV" "LBN" "PER" "URY"`

tab

degisken	yanitlayan	yanitlamayan	SMD
ESCS	-0.826	-1.117	-0.2387
gocmen	0.04097	0.06767	0.118
ev_dijital	1.505	1.356	-0.2142
ST001D01T	9.754	9.604	-0.2108
okul_escs	-0.8321	-1.041	-0.246
W	0.649	0.5558	-0.1913

tab2

program	degisken	SMD
0	ESCS	-0.3185
0	ev_dijital	-0.2654
0	gocmen	0.08694
1	ESCS	-0.1739
1	ev_dijital	-0.176
1	gocmen	0.1465

fark

`      W       W  0.01012 0.00399 `

3. Survey-aware regression with 80 BRR replicate weights (a2_brr_regresyon)

kohort	agirlik	model	terim	est	se	lo	hi	p	n	k	sdY
2018	PISA	M1	W	0.02372	0.02712	-0.02944	0.07687	0.3818	3.558e+05	56	2.581
2018	PISA	M2	W	0.03135	0.02456	-0.01679	0.07949	0.2019	3.558e+05	56	2.581
2018	PISA	M2	WxSD_ESCS	0.05215	0.03303	-0.01258	0.1169	0.1143	3.558e+05	56	2.581
2018	PISA	M2	WxSD_kiz	0.009646	0.02013	-0.02982	0.04911	0.6319	3.558e+05	56	2.581
2018	PISA	M2	WxSD_ev_dijital	-0.03164	0.02613	-0.08285	0.01956	0.2259	3.558e+05	56	2.581
2018	PISA	M2	WxSD_gocmen	0.03119	0.02526	-0.01833	0.0807	0.217	3.558e+05	56	2.581
2018	ESIT	M1	W	0.009931	0.01268	-0.01493	0.03479	0.4336	3.558e+05	56	2.581
2018	ESIT	M2	W	0.01002	0.01269	-0.01485	0.03489	0.4297	3.558e+05	56	2.581
2018	ESIT	M2	WxSD_ESCS	0.04358	0.01405	0.01604	0.07112	0.001925	3.558e+05	56	2.581
2018	ESIT	M2	WxSD_kiz	0.02206	0.01053	0.001427	0.04269	0.03612	3.558e+05	56	2.581
2018	ESIT	M2	WxSD_ev_dijital	-0.01114	0.01494	-0.04043	0.01815	0.4559	3.558e+05	56	2.581
2018	ESIT	M2	WxSD_gocmen	0.01267	0.0116	-0.01006	0.0354	0.2745	3.558e+05	56	2.581
2022	PISA	M1	W	0.02609	0.02439	-0.02171	0.07388	0.2847	3.484e+05	52	2.605
2022	PISA	M2	W	0.01221	0.02291	-0.0327	0.05713	0.594	3.484e+05	52	2.605
2022	PISA	M2	WxSD_ESCS	-0.01187	0.02589	-0.06261	0.03887	0.6466	3.484e+05	52	2.605
2022	PISA	M2	WxSD_kiz	0.01797	0.02572	-0.03244	0.06838	0.4847	3.484e+05	52	2.605
2022	PISA	M2	WxSD_ev_dijital	-0.006835	0.02424	-0.05434	0.04067	0.778	3.484e+05	52	2.605
2022	PISA	M2	WxSD_gocmen	-0.0328	0.02341	-0.07868	0.01308	0.1611	3.484e+05	52	2.605
2022	ESIT	M1	W	0.01942	0.01228	-0.004646	0.04349	0.1137	3.484e+05	52	2.605
2022	ESIT	M2	W	0.01955	0.01232	-0.004598	0.04369	0.1126	3.484e+05	52	2.605
2022	ESIT	M2	WxSD_ESCS	-0.008627	0.01265	-0.03343	0.01618	0.4954	3.484e+05	52	2.605
2022	ESIT	M2	WxSD_kiz	0.05093	0.01128	0.02881	0.07304	6.372e-06	3.484e+05	52	2.605
2022	ESIT	M2	WxSD_ev_dijital	0.03587	0.01417	0.008096	0.06364	0.01136	3.484e+05	52	2.605
2022	ESIT	M2	WxSD_gocmen	-0.00639	0.009733	-0.02547	0.01269	0.5115	3.484e+05	52	2.605

2025	PISA	M1	W	0.0406	0.02107	-0.0007108	0.0819	0.05407	3.315e+05	51	2.377
2025	PISA	M2	W	0.02755	0.0203	-0.01225	0.06734	0.1749	3.315e+05	51	2.377
2025	PISA	M2	WxSD_ESCS	0.001627	0.01871	-0.03505	0.03831	0.9307	3.315e+05	51	2.377
2025	PISA	M2	WxSD_ev_dijital	-0.02086	0.01904	-0.05819	0.01646	0.2732	3.315e+05	51	2.377
2025	PISA	M2	WxSD_gocmen	-0.03607	0.01858	-0.07249	0.0003451	0.05221	3.315e+05	51	2.377
2025	ESIT	M1	W	0.03529	0.01188	0.01201	0.05858	0.002968	3.315e+05	51	2.377
2025	ESIT	M2	W	0.03485	0.0119	0.01152	0.05818	0.003412	3.315e+05	51	2.377
2025	ESIT	M2	WxSD_ESCS	0.02678	0.01121	0.004814	0.04875	0.01687	3.315e+05	51	2.377
2025	ESIT	M2	WxSD_ev_dijital	-0.0144	0.01266	-0.03922	0.01042	0.2554	3.315e+05	51	2.377
2025	ESIT	M2	WxSD_gocmen	-0.02115	0.008227	-0.03727	-0.005021	0.01016	3.315e+05	51	2.377

4. Country-specific associations and random-effects meta-analysis (a4_ulke_duzeyi)

ulke

CNT	est	se	n	schools	p1	kohort	sdY
ALB	0.07663	0.08365	5865	324	0.7368	2018	2.059
ARG	-0.1073	0.1002	1.003e+04	435	0.3193	2018	2.708
AUT	-0.01722	0.07948	6343	278	0.6952	2018	2.591
BGR	-0.1531	0.1086	4278	190	0.7172	2018	2.858
BRA	0.1808	0.1064	8214	556	0.1729	2018	2.861
BRN	0.04246	0.06895	6299	55	0.5832	2018	2.389
CHE	-0.04058	0.08843	5324	226	0.6385	2018	2.256
CHL	-0.07989	0.09942	6242	228	0.24	2018	2.703
COL	0.1679	0.08784	6562	243	0.4588	2018	2.66
CRI	-0.08185	0.08209	6344	205	0.2687	2018	2.286
CZE	-0.1608	0.09691	6368	319	0.4643	2018	2.641
DEU	0.07572	0.1065	3731	180	0.7546	2018	2.529
DOM	0.1742	0.1187	3417	202	0.6139	2018	2.691
ESP	0.007931	0.04919	3.288e+04	1049	0.5539	2018	2.298
EST	0.02319	0.08098	5103	230	0.5896	2018	2.4
FIN	-0.07196	0.07473	5352	204	0.5013	2018	2.178
FRA	-0.03889	0.07242	5200	216	0.7039	2018	2.206
GEO	0.0289	0.09821	4736	316	0.5401	2018	2.632
GRC	-0.04811	0.0916	5918	237	0.3115	2018	2.465
HKG	0.005029	0.127	4153	113	0.8333	2018	2.229
HRV	-0.03135	0.07077	6289	181	0.4201	2018	2.452
HUN	-0.003874	0.0892	4872	230	0.5253	2018	2.504
IDN	-0.03802	0.1039	9672	340	0.5919	2018	2.535
IRL	-0.08217	0.08602	5308	155	0.6943	2018	2.456
ISL	0.03926	0.08119	2987	127	0.6105	2018	2.36
ITA	0.06836	0.07694	1.052e+04	516	0.5368	2018	2.412

JOR	0.1113	0.1083	7949	305	0.6083	2018	3.185
JPN	-0.05304	0.09022	5951	183	0.5405	2018	2.59
KAZ	0.1022	0.05617	1.83e+04	615	0.6841	2018	2.03
KOR	0.06368	0.08284	6402	184	0.7047	2018	2.615
KSV	0.01546	0.09791	4328	203	0.2531	2018	2.38
LBN	-0.1488	0.1427	4017	285	0.4531	2018	2.694
LTU	0.08213	0.07868	6446	362	0.3054	2018	2.414
LUX	-0.08137	0.08378	4874	44	0.7971	2018	2.471
LVA	0.09831	0.07955	4797	294	0.4637	2018	2.38
MAC	0.01031	0.1063	3732	45	0.8061	2018	2.342
MAR	-0.1587	0.1625	4722	175	0.2147	2018	3.056
MDA	-0.06622	0.0901	5002	234	0.585	2018	2.48
MEX	0.04506	0.07367	5917	277	0.3879	2018	2.201
MKD	0.07852	0.09475	4449	103	0.2356	2018	2.3
MLT	-0.08543	0.1038	3102	49	0.7641	2018	2.624
MNE	0.06198	0.07635	6155	61	0.3447	2018	2.822
MYS	0.06091	0.1468	5883	191	0.8259	2018	2.407
NLD	0.01828	0.06153	3578	142	0.6263	2018	1.689
PER	-0.4085	0.08714	4882	332	0.3587	2018	2.52
PHL	0.04258	0.1001	5990	187	0.6012	2018	2.6
POL	0.0904	0.1102	5413	240	0.8253	2018	2.648
PRT	0.04768	0.08324	5465	273	0.6235	2018	2.202
ROU	-0.05672	0.08197	4783	168	0.5433	2018	2.308
SAU	-0.1464	0.1089	5435	232	0.664	2018	2.668
SRB	0.07091	0.08792	5859	185	0.5569	2018	2.638
SVK	0.02534	0.07027	5221	338	0.6031	2018	2.589
SVN	-0.07682	0.07833	5507	284	0.6031	2018	2.742
TAP	0.01309	0.0654	6880	189	0.7498	2018	2.389
THA	0.06934	0.1171	8318	290	0.9001	2018	2.247
URY	-0.0005087	0.09438	4457	187	0.2763	2018	2.486
ALB	-0.1323	0.09395	4828	267	0.6989	2022	2.675
ARG	0.1919	0.09171	1.06e+04	444	0.4288	2022	2.911
AUT	0.03198	0.1013	5496	279	0.7753	2022	2.517
BGR	0.1013	0.1223	5070	182	0.6817	2022	2.83
BRA	0.1127	0.06939	7916	489	0.3684	2022	2.766
BRN	0.1153	0.06962	5214	54	0.5961	2022	2.373
CHE	-0.02356	0.06398	5181	217	0.6823	2022	2.201
CHL	0.05784	0.07365	5295	217	0.3803	2022	2.598
COL	0.04003	0.1014	6738	244	0.6201	2022	2.759
CZE	0.02361	0.06582	8000	415	0.4118	2022	2.597
DEU	-0.1017	0.1139	4200	194	0.8374	2022	2.54
DOM	-0.0352	0.111	4223	187	0.6302	2022	2.835
ESP	0.02662	0.04434	2.686e+04	885	0.6322	2022	2.259
EST	-0.04174	0.06443	6208	195	0.531	2022	2.331
FIN	-0.0153	0.05436	9261	231	0.522	2022	2.156
FRA	-0.09916	0.07281	5248	229	0.6551	2022	2.281
GEO	0.01832	0.08327	5485	252	0.4869	2022	2.612
GRC	0.04406	0.07872	6144	228	0.5331	2022	2.459
HKG	-0.06007	0.1158	3911	109	0.8643	2022	2.212
HRV	0.03018	0.0783	5708	173	0.3507	2022	2.348
HUN	-0.01365	0.07816	5121	226	0.708	2022	2.262
IDN	0.06539	0.09326	1.275e+04	404	0.7669	2022	2.607
ISL	0.1704	0.1063	2783	119	0.689	2022	2.492
ITA	0.0309	0.07093	9787	326	0.7394	2022	2.276

JOR	0.1373	0.1143	7038	260	0.8018	2022	3.101
JPN	-0.01001	0.08638	5617	181	0.5707	2022	2.464
KAZ	0.0176	0.05953	1.942e+04	570	0.6055	2022	2.132
KOR	0.01543	0.09434	6292	185	0.7789	2022	2.434
KSV	-0.09138	0.07856	4578	196	0.3953	2022	2.645
LTU	-0.02438	0.0694	6845	289	0.6269	2022	2.41
LVA	0.08585	0.08924	4417	196	0.3225	2022	2.286
MAC	0.2708	0.09015	4341	46	0.8326	2022	2.211
MAR	0.003521	0.08798	5505	173	0.5569	2022	2.974
MDA	-0.08828	0.07466	5984	264	0.6119	2022	2.67
MEX	0.06447	0.07379	5968	274	0.4657	2022	2.484
MKD	-0.2383	0.07345	5806	108	0.5457	2022	2.69
MLT	0.3606	0.1171	2565	40	0.7425	2022	2.595
MNE	0.1461	0.08357	5460	63	0.3393	2022	2.783
MYS	0.001877	0.06641	6640	199	0.6157	2022	2.511
NLD	0.03101	0.0857	3683	118	0.7903	2022	1.756
PER	0.01454	0.09743	6114	332	0.5299	2022	2.643
PHL	0.07944	0.1078	6747	188	0.7828	2022	2.738
POL	-0.09609	0.07795	5786	238	0.5444	2022	2.646
PRT	0.02061	0.0729	6594	224	0.7701	2022	2.134
ROU	0.05871	0.07319	6857	254	0.5547	2022	2.346
SAU	-0.04625	0.1298	6432	191	0.835	2022	2.843
SRB	0.01815	0.08361	6206	183	0.3762	2022	2.516
SVK	-0.2169	0.08263	5209	262	0.5243	2022	2.599
SVN	0.06734	0.08244	6080	304	0.5403	2022	2.577
TAP	0.01137	0.07321	5706	181	0.6807	2022	2.194
THA	-0.04526	0.08396	8340	279	0.5789	2022	2.374
URY	-0.03776	0.07577	6098	222	0.427	2022	2.403
ALB	0.1379	0.09413	4724	144	0.7441	2025	1.907
ARG	0.02831	0.09592	6069	339	0.4553	2025	2.646
AUT	0.079	0.09807	5683	239	0.7501	2025	2.41
BGR	-0.05142	0.1194	3855	183	0.6548	2025	2.624
BRA	-0.1017	0.05334	2.086e+04	968	0.3974	2025	2.431
BRN	0.1154	0.09317	4788	55	0.7914	2025	2.472
CHE	-0.005808	0.1047	4847	226	0.6951	2025	2.165
CHL	0.04617	0.09496	4026	176	0.3186	2025	2.433
COL	-0.01764	0.07348	5814	254	0.4729	2025	2.346
CZE	0.03932	0.0887	7265	368	0.4292	2025	2.593
DEU	0.09187	0.1249	4054	192	0.8021	2025	2.589
DOM	-0.1052	0.09988	4325	217	0.6896	2025	2.408
ESP	0.04428	0.05236	2.413e+04	906	0.6546	2025	2.144
EST	0.07505	0.06575	5704	197	0.5014	2025	2.21
FIN	0.0483	0.05573	6631	228	0.6159	2025	2.062
FRA	-0.01041	0.08294	3448	196	0.7355	2025	2.314
GEO	0.07403	0.0976	4557	246	0.4978	2025	2.32
GRC	0.0441	0.06925	5937	220	0.5093	2025	2.34
HKG	-0.05147	0.09259	5374	208	0.8846	2025	2.146
HRV	-0.05152	0.05871	5429	260	0.4629	2025	2.138
HUN	0.08437	0.08704	5139	219	0.6068	2025	2.319
IDN	0.07071	0.07451	1.295e+04	417	0.7546	2025	2.26
IRL	-0.06372	0.1356	5500	161	0.8821	2025	2.238
ITA	0.02263	0.07096	7812	270	0.6974	2025	2.172
JOR	-0.04858	0.1652	6168	272	0.8871	2025	3.02
JPN	0.05862	0.0791	6050	182	0.6398	2025	2.392

KAZ	0.0952	0.04696	1.914e+04	632	0.7087	2025	1.945
KOR	-0.2022	0.0944	6255	187	0.7205	2025	2.37
KSV	0.05336	0.09117	3910	175	0.4931	2025	2.277
LBN	0.113	0.121	2588	221	0.5803	2025	2.573
LTU	-0.03229	0.06409	6101	278	0.5591	2025	2.319
LVA	0.0954	0.08699	4927	240	0.2805	2025	2.243
MAR	-0.02281	0.1113	4835	171	0.5718	2025	2.839
MDA	0.008075	0.0884	5370	262	0.5101	2025	2.316
MEX	0.07783	0.07228	7063	290	0.5284	2025	2.189
MKD	0.05685	0.07397	4408	114	0.556	2025	2.311
MNE	0.1825	0.0701	4983	63	0.3706	2025	2.481
MYS	-0.1393	0.07806	6987	155	0.7297	2025	2.252
NLD	-0.1128	0.07342	2467	77	0.569	2025	1.684
PER	0.1336	0.1043	4961	238	0.5421	2025	2.598
PHL	0.1139	0.09414	7355	208	0.8326	2025	2.253
POL	-0.02343	0.08353	6211	210	0.478	2025	2.57
PRT	-0.0841	0.06685	5969	220	0.7481	2025	2.1
ROU	-0.06256	0.06636	6652	316	0.4717	2025	2.201
SAU	0.05519	0.1182	5444	190	0.8676	2025	2.516
SRB	-0.08146	0.09061	5207	169	0.3807	2025	2.32
SVK	0.1483	0.09669	5571	269	0.5083	2025	2.415
SVN	0.1751	0.0696	5516	287	0.5348	2025	2.601
TAP	-0.04118	0.07866	6453	270	0.74	2025	2.383
THA	-0.04207	0.08856	7384	256	0.6465	2025	2.185
URY	-0.05125	0.07655	4569	220	0.3756	2025	2.159

meta

kohort	k	mu	se_mu	lo	hi	tau	I2	Q	Qp	pi_lo	pi_hi	n_pos_sig	n_neg_sig	n_pos	loo_min	loo_max	en_etkili	est_min	est_max
2018	56	0.0006912	0.01225	-0.02332	0.0247	0.03039	11.18	63.86	0.1932	-0.06352	0.0649	0	1	31	-0.002923	0.008754	PER	-0.4085	0.1808
2022	52	0.01358	0.01261	-0.01113	0.03828	0.04178	21.76	69.4	0.04417	-0.07196	0.09911	3	2	33	0.008927	0.01816	MAC	-0.2383	0.3606
2025	51	0.01838	0.01266	-0.006425	0.04319	0.03959	19.88	57.07	0.2291	-0.06309	0.09985	3	1	29	0.01418	0.02317	BRA	-0.2022	0.1825

5. School-level propensity score weighting (a6_okul_ps)

2018

ort

kohort	okul	prog_okul	p_dis_005_095	p_q_prog	p_q_yok
2018	1.401e+04	0.53	0.001537	c(`0%` = 0.0734706175639739, `5%` = 0.26923842113727, `50%` = 0.601554631912991, `95%` = 0.846284939469479, `100%` = 0.965113466948364)	c(`0%` = 0.0605334727191251, `5%` =

0.15273082463838, `50%` = 0.485097783565136, `95%` = 0.741785487375885,
`100%` = 0.956142222458301) |

smd

kohort	degisken	smd_ham	smd_ulke_ici	smd_ipw
2018	okul_escs	0.2976	0.2045	-0.01177
2018	ozel	0.1746	0.1756	-0.01316
2018	konum	0.02176	0.09927	-0.007
2018	sinif	0.02576	-0.01995	-0.03095
2018	gocmen	0.1222	-0.02284	0.02033
2018	ev_dijital	0.1383	0.1354	-0.01572
2018	kiz	0.02526	0.02286	0.0291

est

kohort	ipw_est	ipw_se	ipw_lo	ipw_hi	duz_est	sdY	n
2018	0.02956	0.02606	-0.02151	0.08063	0.02372	2.581	3.558e+05

2022

ort

kohort	okul	prog_okul	p_dis_005_095	p_q_prog	p_q_yok
2022	1.259e+04	0.5921	0.0003918	c(`0%` = 0.188072882917506, `5%` = 0.347159200560536, `50%` = 0.625955578703747, `95%` = 0.853373660996827, `100%` = 0.981609387221005)	c(`0%` = 0.0272043763889671, `5%` = 0.303930449546654, `50%` = 0.536957957005729, `95%` = 0.793189092812521, `100%` = 0.953111088664387)

smd

kohort	degisken	smd_ham	smd_ulke_ici	smd_ipw
2022	okul_escs	0.1123	0.2293	0.02143
2022	ozel	0.2988	0.2276	0.02563
2022	konum	-0.05186	0.02589	-0.01357
2022	sinif	0.01154	0.04176	0.03198
2022	gocmen	0.04614	-0.06682	-0.03153
2022	ev_dijital	-0.003375	0.2035	0.08883
2022	kiz	-0.0003503	-0.01253	-0.03118

est

kohort	ipw_est	ipw_se	ipw_lo	ipw_hi	duz_est	sdY	n
2022	0.02291	0.02646	-0.02894	0.07477	0.02609	2.605	3.484e+05

2025

ort

kohort	okul	prog_okul	p_dis_005_095	p_q_prog	p_q_yok
2025	1.306e+04	0.588	0	c(`0%` = 0.181186603387408, `5%` = 0.373551996455416, `50%` = 0.651578461912067, `95%` = 0.880029941126684, `100%` = 0.933586237570807)	c(`0%` = 0.186169055037362, `5%` = 0.315643443711935, `50%` = 0.506145788486235, `95%` = 0.780379157453334, `100%` = 0.933479084625407)

smd

kohort	degisken	smd_ham	smd_ulke_ici	smd_ipw
2025	okul_escs	0.04446	0.0805	-0.01626
2025	ozel	0.1682	0.1191	-0.02058
2025	konum	0.01252	0.07536	0.002811
2025	sinif	-0.2095	-0.1401	-0.1222
2025	gocmen	0.08423	0.002887	0.01521
2025	ev_dijital	-0.01313	0.07567	0.02272

est

kohort	ipw_est	ipw_se	ipw_lo	ipw_hi	duz_est	sdY	n
2025	0.04799	0.02245	0.003994	0.09199	0.0406	2.377	3.315e+05

6. 2025 missing-data forests (a1_orman_A, a1_orman_B, a1_orman_IPW)

set	countries	n	ate	se	RATE	RATE_se
A	45	3.061e+05	-0.0002897	0.02679	-0.00424	0.02208
B	40	2.678e+05	0.01497	0.02891	0.01929	0.03103
IPW	51	3.315e+05	-0.002143	0.02531		

BLP, set A

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.00363	0.02723	-0.1333	0.894
ESCS	0.02101	0.02812	0.747	0.4551
ev_dijital	-0.02382	0.02593	-0.9185	0.3584
gocmen	-0.01886	0.02474	-0.7624	0.4458

BLP, set B

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.01728	0.02873	0.6013	0.5477

ESCS	0.0344	0.03037	1.133	0.2573
ev_dijital	-0.0168	0.02977	-0.5644	0.5725
gocmen	-0.03996	0.02804	-1.425	0.1541

BLP, set IPW

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.009978	0.02706	-0.3688	0.7123
ESCS	0.009857	0.02739	0.3598	0.719
ev_dijital	-0.01984	0.02451	-0.8096	0.4182
gocmen	-0.0285	0.02231	-1.277	0.2014

7. Direct contrasts between outcomes (H4) and independent 2025 forest (a5_h4_kontrast_blp25)

Forest (AIPW) contrasts, SD units, favourable direction positive:

kontrast	est	se	lo	hi	p
BASKI_YD	-0.009173	0.01545	-0.03945	0.02111	0.5527
KAYGI_YD	-0.008692	0.01675	-0.04152	0.02413	0.6038
YAKIN_ORT_YD	-0.008932	0.01493	-0.03819	0.02032	0.5495
BASKI_KAYGI	-0.0004807	0.01213	-0.02426	0.0233	0.9684

Replicate-weight regression contrasts:

kontrast	est	se	lo	hi	p
BASKI_YD	-0.0094	0.01157	-0.03208	0.01328	0.4167
KAYGI_YD	-0.01044	0.01182	-0.03361	0.01273	0.3773
YAKIN_ORT_YD	-0.009918	0.01066	-0.0308	0.01097	0.3519
BASKI_KAYGI	0.001037	0.009659	-0.01789	0.01997	0.9145

Independent 2025 forest, best linear projection:

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.01239	0.02735	-0.4533	0.6504
ESCS	0.0111	0.02747	0.4039	0.6863
ev_dijital	-0.02394	0.02417	-0.9905	0.3219
gocmen	-0.02241	0.02228	-1.006	0.3144

Calibration test:

term	Estimate	Std. Error	t value	Pr(>t)
mean.forest.prediction	43.96	264.2	0.1664	0.4339
differential.forest.prediction	0.2562	0.1064	2.408	0.008024

8. Forests with equal-country weights (a2_orman_esit_ulke)

2018 (n = 355825, countries = 56)

Average association: -0.02403 (SE 0.0152)

BLP:

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.02392	0.01513	-1.58	0.114
ESCS	0.01809	0.01437	1.259	0.2081
ev_dijital	-0.0298	0.0151	-1.974	0.04838
kiz	0.02732	0.01178	2.319	0.02037
gocmen	0.004041	0.01244	0.3249	0.7452

Calibration:

term	Estimate	Std. Error	t value	Pr(>t)
mean.forest.prediction	1.063	0.743	1.431	0.0762
differential.forest.prediction	0.3593	0.07626	4.712	1.228e-06

2022 (n = 348364, countries = 52)

Average association: 0.01012 (SE 0.0161)

BLP:

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.009727	0.01609	0.6044	0.5456
ESCS	-0.02674	0.014	-1.909	0.05622
ev_dijital	0.02869	0.01412	2.031	0.04221
kiz	0.01992	0.0129	1.544	0.1226
gocmen	-0.01349	0.01321	-1.021	0.3071

Calibration:

term	Estimate	Std. Error	t value	Pr(>t)
mean.forest.prediction	0.8653	1.99	0.4347	0.3319
differential.forest.prediction	0.1392	0.0749	1.858	0.03155

2025 (n = 331471, countries = 51)

Average association: -0.01492 (SE 0.0156)

BLP:

term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.01447	0.01558	-0.9291	0.3528
ESCS	0.005705	0.01464	0.3896	0.6968
ev_dijital	-0.01169	0.01378	-0.8483	0.3963
gocmen	-0.0268	0.01168	-2.294	0.02182

Calibration:

term	Estimate	Std. Error	t value	Pr(>t)
mean.forest.prediction	1.026	1.542	0.6652	0.253
differential.forest.prediction	0.04208	0.08945	0.4704	0.319

9. Largest magnitude excluded and exploratory equivalence tests (a3_esdegerlik)

No smallest effect size of interest was fixed in advance; TOST at 0.05 and 0.10 SD is exploratory.

id	yontem	est	se	est_sd	lo95	hi95	disla	tost_p05	tost_p10
F18	Nedensel orman (birincil, PISA agirligi)	0.001652	0.03485	0.0006402	-0.02583	0.02711	0.02711	0.0001283	9.304e-14
F22	Nedensel orman (PISA agirligi)	0.05048	0.03248	0.01938	-0.005059	0.04381	0.04381	0.007019	5.004e-11
F25	Nedensel orman (birincil, PISA agirligi)	0.006022	0.02469	0.002533	-0.01782	0.02289	0.02289	2.429e-06	3.13e-21
F18S	Orman, 6 yuksek yanitsizlikli ulke cikarildi (2018 orneklemi)	0.01839	0.0364	0.007123	-0.02052	0.03476	0.03476	0.001181	2.255e-11
R2018PISA	Anket bilincli regresyon, PISA agirligi	0.02372	0.02712	0.00919	-0.01141	0.02978	0.02978	5.141e-05	2.757e-18
R2018ESIT	Anket bilincli regresyon, esit ulke agirligi	0.009931	0.01268	0.003848	-0.005783	0.01348	0.01348	2.938e-21	1.466e-85
R2022PISA	Anket bilincli regresyon, PISA agirligi	0.02609	0.02439	0.01001	-0.008332	0.02836	0.02836	9.677e-06	3.481e-22
R2022ESIT	Anket bilincli regresyon, esit ulke agirligi	0.01942	0.01228	0.007454	-0.001783	0.01669	0.01669	8.753e-20	3.71e-86
R2025PISA	Anket bilincli regresyon, PISA agirligi	0.0406	0.02107	0.01708	-0.000299	0.03445	0.03445	0.0001022	4.246e-21
R2025ESIT	Anket bilincli regresyon, esit ulke agirligi	0.03529	0.01188	0.01485	0.005052	0.02464	0.02464	1.001e-12	2.081e-65
MA	Orman, onceden belirlenen 6 ulke cikarildi (2025)	-0.0002897	0.02679	-0.0001219	-0.02221	0.02197	0.02221	4.811e-06	3.242e-19
MB	Orman, sonuc eksikligi > %20 olan 11 ulke cikarildi (2025)	0.01497	0.02891	0.006298	-0.01754	0.03013	0.03013	0.0001631	6.539e-15
MIPW	Orman, yanitlama olasiligi ters agirligi (2025)	-0.002143	0.02531	-0.0009017	-0.02177	0.01997	0.02177	2.006e-06	1.326e-21
FE2018	Nedensel orman, esit ulke agirligi	-0.02403	0.01517	-0.009309	-0.02083	0.002209	0.02083	2.194e-12	1.595e-77
FE2022	Nedensel orman, esit ulke agirligi	0.01012	0.01607	0.003883	-0.008209	0.01597	0.01597	3.839e-14	4.914e-55
FE2025	Nedensel orman, esit ulke agirligi	-0.01492	0.01559	-0.006275	-0.01913	0.006579	0.01913	1.3e-11	2.302e-59

P2018	Egilim skoru (IPW) ile agirlikli regresyon	0.02956	0.02606	0.01145	-0.008334	0.03124	0.03124	6.712e-05	8.815e-19
P2022	Egilim skoru (IPW) ile agirlikli regresyon	0.02291	0.02646	0.008795	-0.01111	0.0287	0.0287	2.48e-05	1.341e-19
P2025	Egilim skoru (IPW) ile agirlikli regresyon	0.04799	0.02245	0.02019	0.00168	0.0387	0.0387	0.0007967	1.43e-17
U2018	Ulke duzeyi rastgele etkili meta-analiz (ortalama)	0.0006912	0.01225	0.0002678	-0.009034	0.00957	0.00957	5.399e-26	2.429e-98
U2022	Ulke duzeyi rastgele etkili meta-analiz (ortalama)	0.01358	0.01261	0.00521	-0.004274	0.01469	0.01469	1.058e-20	9.529e-86
U2025	Ulke duzeyi rastgele etkili meta-analiz (ortalama)	0.01838	0.01266	0.007732	-0.002703	0.01817	0.01817	1.018e-15	1.383e-67

H4 outcomes (SD units):

sonuc	est_sd	se_sd	lo95	hi95	disla	tost_p05	tost_p10	dmin
Yasam doyumu	0.002208	0.01067	-0.01871	0.02313	0.02313	3.78e-06	2.56e-20	0.01977
Baski (ters)	-0.003723	0.01163	-0.02652	0.01907	0.02652	3.464e-05	1.11e-16	0.02285
Kaygi (ters)	-0.008261	0.0123	-0.03236	0.01584	0.03236	0.0003435	4.285e-14	0.02849

10. a7_ortak_ulke_program

```
$ct
 [1] "ALB" "ARG" "AUT" "BRA" "BRN" "BGR" "CHL" "TAP" "COL" "HRV" "CZE"
"DOM" "EST" "FIN" "FRA" "GEO"
[17] "DEU" "GRC" "HKG" "HUN" "IDN" "ITA" "KSV" "KAZ" "JOR" "KOR" "LVA"
"LTU" "MYS" "MEX" "MDA" "MNE"
[33] "MAR" "NLD" "PER" "PHL" "POL" "PRT" "ROU" "SAU" "SRB" "SVK" "SVN"
"ESP" "CHE" "THA" "MKD" "URY"

$tab
       yr  k students schools pct_students pct_schools pct_students_eq
[1,] 2018 48   312639   12910         53.8        53.2            54.3
[2,] 2022 48   323424   12192         63.7        59.0            59.4
[3,] 2025 48   309843   12480         65.0        58.5            59.9
```

11. a8_nr_ozet

```
$n_base
[1] 368662

$n_resp
```

```
[1] 331471

$nr
[1] 0.0881

$nr_prog1
[1] 0.0764

$nr_prog0
[1] 0.109

$prog_all
[1] 0.641

$prog_resp
[1] 0.649

$diff_pp
[1] 0.821
```

12. Run logs

log_09b.txt

```
[ 2026-10-26 02:34:21 ] Kume A ulke: 45
   bitti: 96.3 dk
[ 2026-10-26 04:10:37 ] Kume B ulke: 40
   bitti: 14.5 dk
[ 2026-10-26 04:25:09 ] IPW
p-hat ozet (yanitlayanlar): 0.196 0.656 0.923 0.991 0.994
[ 2026-10-26 04:29:52 ] TAMAM
```

log_10a.txt

```
2018 tamam
        kohort agirlik model terim     est     se      lo     hi     p
n
PISA_M1   2018    PISA    M1     W 0.02372 0.0271 -0.0294 0.0769 0.382
355825
ESIT_M1   2018    ESIT    M1     W 0.00993 0.0127 -0.0149 0.0348 0.434
355825
         k  sdY
PISA_M1 56 2.58
ESIT_M1 56 2.58
2022 tamam
2025 tamam
 kohort agirlik     est     se        lo     hi       p      n  k
   2018    PISA 0.02372 0.0271 -0.029438 0.0769 0.38182 355825 56
   2018    ESIT 0.00993 0.0127 -0.014927 0.0348 0.43360 355825 56
```

```
   2022    PISA 0.02609 0.0244 -0.021709 0.0739 0.28471 348364 52
   2022    ESIT 0.01942 0.0123 -0.004646 0.0435 0.11374 348364 52
   2025    PISA 0.04060 0.0211 -0.000711 0.0819 0.05407 331471 51
   2025    ESIT 0.03529 0.0119  0.012010 0.0586 0.00297 331471 51
```

log_10b.txt

```
2018 tamam
 kohort  k       mu  se_mu      lo     hi    tau   I2    Q    Qp   pi_lo
pi_hi
   2018 56 0.000691 0.0122 -0.0233 0.0247 0.0304 11.2 63.9 0.193 -0.0635
0.0649
 n_pos_sig n_neg_sig n_pos  loo_min loo_max en_etkili est_min est_max
         0         1    31 -0.00292 0.00875       PER  -0.409   0.181
2022 tamam
 kohort  k     mu  se_mu      lo     hi    tau   I2    Q     Qp  pi_lo
pi_hi
   2022 52 0.0136 0.0126 -0.0111 0.0383 0.0418 21.8 69.4 0.0442 -0.072
0.0991
 n_pos_sig n_neg_sig n_pos loo_min loo_max en_etkili est_min est_max
         3         2    33 0.00893  0.0182       MAC  -0.238   0.361
2025 tamam
 kohort  k     mu  se_mu       lo     hi    tau   I2    Q    Qp   pi_lo
pi_hi
   2025 51 0.0184 0.0127 -0.00643 0.0432 0.0396 19.9 57.1 0.229 -0.0631
0.0998
 n_pos_sig n_neg_sig n_pos loo_min loo_max en_etkili est_min est_max
         3         1    29  0.0142  0.0232       BRA  -0.202   0.183
TAMAM
```

log_10c.txt

```
2018 tamam
 kohort ipw_est ipw_se  ipw_lo ipw_hi duz_est  sdY      n
   2018  0.0296 0.0261 -0.0215 0.0806  0.0237 2.58 355825
 kohort   degisken smd_ham smd_ulke_ici smd_ipw
   2018  okul_escs   0.298        0.204  -0.012
   2018       ozel   0.175        0.176  -0.013
   2018      konum   0.022        0.099  -0.007
   2018      sinif   0.026       -0.020  -0.031
   2018     gocmen   0.122       -0.023   0.020
   2018 ev_dijital   0.138        0.135  -0.016
   2018        kiz   0.025        0.023   0.029
 kohort  okul prog_okul p_dis_005_095
   2018 14012      0.53       0.00154
2022 tamam
 kohort ipw_est ipw_se  ipw_lo ipw_hi duz_est  sdY      n
   2022  0.0229 0.0265 -0.0289 0.0748  0.0261 2.61 348364
 kohort   degisken  smd_ham smd_ulke_ici smd_ipw
   2022  okul_escs  0.11231        0.229   0.021
```

```
   2022       ozel  0.29882        0.228   0.026
   2022      konum -0.05186        0.026  -0.014
   2022      sinif  0.01154        0.042   0.032
   2022     gocmen  0.04614       -0.067  -0.032
   2022 ev_dijital -0.00337        0.204   0.089
   2022        kiz -0.00035       -0.013  -0.031
 kohort  okul prog_okul p_dis_005_095
   2022 12586     0.592      0.000392
2025 tamam
 kohort ipw_est ipw_se  ipw_lo ipw_hi duz_est  sdY      n
   2025   0.048 0.0224 0.00399  0.092  0.0406 2.38 331471
 kohort   degisken smd_ham smd_ulke_ici smd_ipw
   2025  okul_escs   0.044       0.0805 -0.0163
   2025       ozel   0.168       0.1191 -0.0206
   2025      konum   0.013       0.0754  0.0028
   2025      sinif  -0.210      -0.1401 -0.1222
   2025     gocmen   0.084       0.0029  0.0152
   2025 ev_dijital  -0.013       0.0757  0.0227
 kohort  okul prog_okul p_dis_005_095
   2025 13061     0.588            0
TAMAM
```

log_11.txt

```
Ortak orneklem n = 313974 | ulke = 51 | okul = 13004
Dogrulama (grf vs el hesabi):
YD grf: 0.00205 0.01016 | el: 0.00205 0.01016
BASKI grf: -0.00712 0.01186 | el: -0.00712 0.01186
KAYGI grf: -0.00664 0.01283 | el: -0.00664 0.01283

Orman (AIPW) kontrastlari, SD birimi, elverisli yon +:
     kontrast       est     se      lo     hi     p
     BASKI_YD -0.009173 0.0154 -0.0395 0.0211 0.553
     KAYGI_YD -0.008692 0.0167 -0.0415 0.0241 0.604
 YAKIN_ORT_YD -0.008932 0.0149 -0.0382 0.0203 0.550
  BASKI_KAYGI -0.000481 0.0121 -0.0243 0.0233 0.968

BRR regresyon katsayilari (hizali SD):
 sonuc     est      se
    YD 0.01789 0.00924
 BASKI 0.00849 0.00958
 KAYGI 0.00745 0.00960

BRR kontrastlari:
     kontrast      est      se      lo     hi     p
     BASKI_YD -0.00940 0.01157 -0.0321 0.0133 0.417
     KAYGI_YD -0.01044 0.01182 -0.0336 0.0127 0.377
 YAKIN_ORT_YD -0.00992 0.01066 -0.0308 0.0110 0.352
  BASKI_KAYGI  0.00104 0.00966 -0.0179 0.0200 0.914

2025 BLP (yasam doyumu, puan/SD):
```

```
Best linear projection of the conditional average treatment effect.
Confidence intervals are cluster- and heteroskedasticity-robust (HC3):

            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.0124     0.0273   -0.45     0.65
ESCS          0.0111     0.0275    0.40     0.69
ev_dijital   -0.0239     0.0242   -0.99     0.32
gocmen       -0.0224     0.0223   -1.01     0.31


Best linear fit using forest predictions (on held-out data)
as well as the mean forest prediction as regressors, along
with one-sided heteroskedasticity-robust (HC3) SEs:

                                Estimate Std. Error t value   Pr(>t)
mean.forest.prediction          43.96296  264.21585  0.1664 0.433925
differential.forest.prediction   0.25618    0.10639  2.4078 0.008024 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

TAMAM
```

log_12.txt

```
2018 tamam
   estimate     std.err
-0.02402675  0.01516777

Best linear projection of the conditional average treatment effect.
Confidence intervals are cluster- and heteroskedasticity-robust (HC3):

              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0239179  0.0151348 -1.5803  0.11403
ESCS         0.0180882  0.0143688  1.2588  0.20809
ev_dijital  -0.0298044  0.0150985 -1.9740  0.04838 *
kiz          0.0273197  0.0117785  2.3194  0.02037 *
gocmen       0.0040411  0.0124368  0.3249  0.74523
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

2022 tamam
  estimate    std.err
0.01011550 0.01607267

Best linear projection of the conditional average treatment effect.
Confidence intervals are cluster- and heteroskedasticity-robust (HC3):

              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.0097274  0.0160938  0.6044  0.54557
ESCS        -0.0267373  0.0140034 -1.9093  0.05622 .
ev_dijital   0.0286905  0.0141229  2.0315  0.04221 *
kiz          0.0199219  0.0129043  1.5438  0.12263
```

```
gocmen      -0.0134906  0.0132077 -1.0214  0.30706
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

2025 tamam
   estimate     std.err
-0.01491576  0.01558907

Best linear projection of the conditional average treatment effect.
Confidence intervals are cluster- and heteroskedasticity-robust (HC3):

              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0144718  0.0155761 -0.9291  0.35283
ESCS         0.0057052  0.0146423  0.3896  0.69680
ev_dijital  -0.0116897  0.0137803 -0.8483  0.39628
gocmen      -0.0267956  0.0116832 -2.2935  0.02182 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

TAMAM
```

13. Script code

08_ortak.R

```r
# ========================================================================
# 08_ortak.R | Digital Resilience | REVIZYON 1 (JPSP-50050-2026)
# Ortak yardimcilar: hazirlik, forest, BRR (Fay 0.5, 80 yineleme)
varyansi
# Hazirlik ve forest ayarlari 02/03/05 betikleriyle ayni (2000 agac, seed
20260923)
# ========================================================================
suppressPackageStartupMessages({ library(grf); library(dplyr) })
P <-
"C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_Causal_F
orest_"
O <- file.path(P, "prepared"); R1 <- file.path(P, "revision");
dir.create(R1, showWarnings = FALSE)
u <- readLines(file.path(O, "analiz_ulkeleri.txt"), warn = FALSE)
ana56 <- strsplit(u[2], " ")[[1]]; stres53 <- strsplit(u[4], " ")[[1]]
SEED <- 20260923
RW <- paste0("W_FSTURWT", 1:80)

hz <- function(d, ulke, kiz = TRUE) {
  d <- d |> filter(CNT %in% ulke) |>
    mutate(CNT = as.character(CNT), W = as.integer(program == 1), Y =
ST016Q01NA,
           gocmen = as.integer(IMMIG %in% 2:3), ev_dijital = (ev_pc == 1)
+ (ev_net == 1),
           okul_escs = ave(ESCS, CNTSCHID, FUN = function(v) mean(v,
na.rm = TRUE)))
```

```
  if (kiz) d$kiz <- as.integer(d$ST004D01T == 1)
  gerekli <- c("W", "Y", "ESCS", "gocmen", "ev_dijital", if (kiz) "kiz")
  d[stats::complete.cases(d[, gerekli]), ]
}
Xcols <- function(kiz) c("ESCS", if (kiz) "kiz", "gocmen", "ev_dijital",
"ST001D01T", "okul_escs", "SC013Q01TA", "SC001Q01TA")
Xf <- function(d, ulke, kiz = TRUE) cbind(as.matrix(d[, Xcols(kiz)]),
model.matrix(~ factor(CNT, levels = ulke) - 1, d))
orman <- function(d, ulke, y = d$Y, kiz = TRUE, w = d$W_FSTUWT, seed =
SEED)
  causal_forest(Xf(d, ulke, kiz), y, d$W, sample.weights = w, clusters =
as.integer(factor(d$CNTSCHID)),
                equalize.cluster.weights = FALSE, num.trees = 2000, seed
= seed)

# BRR-Fay (PISA): Var = sum_r (theta_r - theta)^2 / (G (1-k)^2), G = 80,
k = .5  => /20
brr_se <- function(t0, tr) sqrt(sum((tr - t0)^2) / 20)

# Ortak: normal denklemlerle agirlikli en kucuk kareler (hizli); katsayi
vektoru dondurur
wls <- function(X, y, w) { A <- crossprod(X, w * X); b <- crossprod(X, w
* y); drop(solve(A, b)) }

# Okul kovaryatlarindaki eksikleri 0 + eksik gostergesiyle doldur (yalniz
regresyon icin)
doldur <- function(d, kolon) { for (k in kolon) { na <- is.na(d[[k]]);
d[[paste0(k, "_na")]] <- as.numeric(na); d[[k]][na] <- 0 }; d }

```

09a_yanitsizlik_betimsel.R

```r

# 09a_yanitsizlik_betimsel.R | Hakem 1, madde 4: 2025 yanitsizlik profili
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/08_ortak.R")
d <- readRDS(file.path(O, "dr_2025.rds")) |> filter(CNT %in% ana56) |>
  mutate(CNT = as.character(CNT), W = as.integer(program == 1), gocmen =
as.integer(IMMIG %in% 2:3),
         ev_dijital = (ev_pc == 1) + (ev_net == 1), okul_escs = ave(ESCS,
CNTSCHID, FUN = function(v) mean(v, na.rm = TRUE)))
# taban: program ve kovaryatlari (cinsiyet haric) gozlenen ogrenciler;
sonuc eksikligi ayri izlenir
B <- d[stats::complete.cases(d[, c("W", "ESCS", "gocmen",
"ev_dijital")]), ]
B$R <- as.integer(!is.na(B$ST016Q01NA))
cat("Taban (51 ulke olmasi beklenir) ulke sayisi:",
length(unique(B$CNT)), "| n:", nrow(B), "| yanitlayan:", sum(B$R), "\n")
wm <- function(x, w) sum(x * w) / sum(w)
ulke <- do.call(rbind, lapply(split(B, B$CNT), function(z) data.frame(CNT
= z$CNT[1], n = nrow(z),
```

```
  nr = 1 - wm(z$R, z$W_FSTUWT), nr_prog1 = 1 - wm(z$R[z$W == 1],
z$W_FSTUWT[z$W == 1]), nr_prog0 = 1 - wm(z$R[z$W == 0], z$W_FSTUWT[z$W ==
0])))) 
ulke$fark_1m0 <- ulke$nr_prog1 - ulke$nr_prog0
cat("\nUlke bazli yanitsizlik (agirlikli), en yuksek 12:\n");
print(head(ulke[order(-ulke$nr), ], 12), row.names = FALSE, digits = 3)
yuksek25 <- ulke$CNT[ulke$nr > .20]; cat("\n2025'te yanitsizlik > %20
olan ulkeler (", length(yuksek25), "):", paste(yuksek25, collapse = " "),
"\n")
cat("Onceki duyarlilikta cikarilan alti ulke ayni mi? ",
setequal(yuksek25, c("ARG","BGR","KSV","LBN","MKD","URY")), "\n")
# genel ve programa gore
gen <- function(z) c(n = nrow(z), nr = 1 - wm(z$R, z$W_FSTUWT))
cat("\nGenel yanitsizlik (agirlikli):", round(gen(B)["nr"], 4), "\n")
for (w in 0:1) cat("  Program =", w, ": n =", sum(B$W == w), "|
yanitsizlik =", round(1 - wm(B$R[B$W == w], B$W_FSTUWT[B$W == w]), 4),
"\n")
# programa gore fark: ulke sabit etkili agirlikli lojistik/dogrusal (okul
kumeli)
m1 <- lm(R ~ W + factor(CNT), data = B, weights = W_FSTUWT)
vc <- sandwich::vcovCL(m1, cluster = B$CNTSCHID); se <-
sqrt(diag(vc))["W"]
cat("\nYanitlama olasiligi farki (program 1 - 0), ulke sabit etkili, okul
kumeli:", round(coef(m1)["W"], 4), "SE", round(se, 4), "\n")
# yanitlayan / yanitlamayan karsilastirma (standartlastirilmis fark)
smd <- function(v, g) { z <- B[!is.na(B[[v]]), ]; a <- z[[v]][z$R == 1];
b <- z[[v]][z$R == 0]; wa <- z$W_FSTUWT[z$R == 1]; wb <- z$W_FSTUWT[z$R
== 0]
  ma <- wm(a, wa); mb <- wm(b, wb); sp <- sqrt((wm((a - ma)^2, wa) +
wm((b - mb)^2, wb)) / 2); c(yanitlayan = ma, yanitlamayan = mb, SMD = (mb
- ma) / sp) }
vars <- c("ESCS", "gocmen", "ev_dijital", "ST001D01T", "okul_escs", "W")
tab <- do.call(rbind, lapply(vars, function(v) data.frame(degisken = v,
t(smd(v)))))
cat("\nYanitlamayan - yanitlayan (SMD = standartlastirilmis fark), tum 51
ulke:\n"); print(tab, row.names = FALSE, digits = 3)
tab2 <- do.call(rbind, lapply(0:1, function(w) { B2 <- B[B$W == w, ];
do.call(rbind, lapply(c("ESCS", "ev_dijital", "gocmen"), function(v) { z
<- B2[!is.na(B2[[v]]), ]; a <- z[[v]][z$R == 1]; b <- z[[v]][z$R == 0];
wa <- z$W_FSTUWT[z$R == 1]; wb <- z$W_FSTUWT[z$R == 0]
  ma <- wm(a, wa); mb <- wm(b, wb); sp <- sqrt((wm((a - ma)^2, wa) +
wm((b - mb)^2, wb)) / 2); data.frame(program = w, degisken = v, SMD = (mb
- ma) / sp) })) }))
cat("\nProgram durumuna gore SMD (yanitlamayan - yanitlayan):\n");
print(tab2, row.names = FALSE, digits = 3)
saveRDS(list(ulke = ulke, yuksek25 = yuksek25, tab = tab, tab2 = tab2,
fark = c(coef(m1)["W"], se)), file.path(R1,
"a1_yanitsizlik_betimsel.rds"))
```

09b_yanitsizlik_orman.R

```r
```

```
# 09b_yanitsizlik_orman.R | Hakem 1, madde 4: 2025 birincil analizlerin
yanitsizlik duyarliligi
#  A  = onceden belirlenen alti ulke cikarilir (ARG BGR KSV LBN MKD URY)
-> 45 ulke
#  B  = sonuc eksikligi > %20 olan 11 ulke cikarilir
-> 40 ulke
#  IPW= 51 ulke, yanitlama olasiligi ters agirligi (lojistik model)
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/08_ortak.R")
eff51 <- setdiff(ana56, c("ISL", "LUX", "MAC", "MLT", "CRI"))
setA <- setdiff(eff51, c("ARG", "BGR", "KSV", "LBN", "MKD", "URY"))
setB <- setdiff(eff51, c("ARG", "BGR", "BRA", "CHL", "DEU", "DOM", "KSV",
"LBN", "MKD", "PER", "URY"))
r18 <- readRDS(file.path(O, "dr_2018.rds")); r25 <- readRDS(file.path(O,
"dr_2025.rds"))
wsd <- function(y, w) sqrt(sum(w * (y - sum(w * y) / sum(w))^2) / sum(w))
bilesen <- function(c25, d25, set, oncelik = NULL) {
  ate <- average_treatment_effect(c25); sdY <- wsd(d25$Y, d25$W_FSTUWT)
  out <- list(n = nrow(d25), k = length(unique(d25$CNT)), okul =
length(unique(d25$CNTSCHID)), sdY = sdY, ate = ate,
              blp = best_linear_projection(c25, scale(d25[, c("ESCS",
"ev_dijital", "gocmen")])))
  if (!is.null(oncelik)) out$rate <- rank_average_treatment_effect(c25,
priorities = oncelik)
  out
}
h4 <- function(d25, set) lapply(c("ST322Q06JA", "ST322Q07JA"),
function(v) { dd <- d25[!is.na(d25[[v]]), ]; z <-
as.numeric(scale(dd[[v]]))
  a <- average_treatment_effect(orman(dd, set, y = z, kiz = FALSE));
list(sonuc = v, n = nrow(dd), ate = a) }) |> setNames(c("baski",
"kaygi"))

for (nm in c("A", "B")) {
  set <- get(paste0("set", nm)); t0 <- Sys.time(); cat("[",
format(Sys.time()), "] Kume", nm, "ulke:", length(set), "\n")
  d18 <- hz(r18, set, kiz = FALSE); d25 <- hz(r25, set, kiz = FALSE)
  c18 <- orman(d18, set, kiz = FALSE); c25 <- orman(d25, set, kiz =
FALSE)
  onc <- predict(c18, Xf(d25, set, kiz = FALSE))$predictions
  res <- bilesen(c25, d25, set, onc); res$h4 <- h4(d25, set); res$set <-
set; res$n18 <- nrow(d18)
  saveRDS(res, file.path(R1, paste0("a1_orman_", nm, ".rds"))); rm(c18,
c25, d18, d25); gc()
  cat("   bitti:", round(difftime(Sys.time(), t0, units = "mins"), 1),
"dk\n")
}
# --- IPW (51 ulke) ----
cat("[", format(Sys.time()), "] IPW\n")
d <- r25 |> filter(CNT %in% eff51) |> mutate(CNT = as.character(CNT), W =
as.integer(program == 1), gocmen = as.integer(IMMIG %in% 2:3),
        ev_dijital = (ev_pc == 1) + (ev_net == 1), okul_escs = ave(ESCS,
CNTSCHID, FUN = function(v) mean(v, na.rm = TRUE)))
```

```
B <- d[stats::complete.cases(d[, c("W", "ESCS", "gocmen",
"ev_dijital")]), ]; B$R <- as.integer(!is.na(B$ST016Q01NA))
Bz <- doldur(B, c("ST001D01T", "SC013Q01TA", "SC001Q01TA"))
f <- R ~ W + ESCS + gocmen + ev_dijital + ST001D01T + ST001D01T_na +
okul_escs + SC013Q01TA + SC013Q01TA_na + SC001Q01TA + SC001Q01TA_na +
factor(CNT)
gm <- glm(f, data = Bz, family = binomial()); Bz$p <- pmax(predict(gm,
type = "response"), 0.05)
cat("p-hat ozet (yanitlayanlar):", paste(round(quantile(Bz$p[Bz$R == 1],
c(0, .01, .5, .99, 1)), 3), collapse = " "), "\n")
Bz$ipw <- Bz$W_FSTUWT / Bz$p
dr <- Bz[Bz$R == 1, ]; dr$Y <- dr$ST016Q01NA
cI <- orman(dr, eff51, kiz = FALSE, w = dr$ipw)
resI <- bilesen(cI, dr, eff51); resI$phat <- quantile(Bz$p[Bz$R == 1],
c(0, .01, .5, .99, 1)); resI$auc_not <- "p-hat alt sinir 0.05"
saveRDS(resI, file.path(R1, "a1_orman_IPW.rds")); cat("[",
format(Sys.time()), "] TAMAM\n")
```

10_regfun.R

```r
# 10_regfun.R | 10a ile ayni fonksiyonlar (FWL ile ulke sabit etkili WLS,
BRR)
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/08_ortak.R")
wsd <- function(y, w) sqrt(sum(w * (y - sum(w * y) / sum(w))^2) / sum(w))
wm  <- function(x, w) sum(x * w) / sum(w)
fe_fit <- function(Z, y, ci, w) {
  M <- cbind(y, Z); tot <- rowsum(w, ci)[, 1]; cm <- rowsum(w * M, ci) /
tot; Md <- M - cm[ci, , drop = FALSE]
  Zd <- Md[, -1, drop = FALSE]; drop(solve(crossprod(Zd, w * Zd),
crossprod(Zd, w * Md[, 1])))
}
tasarim <- function(d, kiz) {
  d <- doldur(d, c("ST001D01T", "SC013Q01TA", "SC001Q01TA")); mods <-
c("ESCS", if (kiz) "kiz", "ev_dijital", "gocmen")
  base <- cbind(W = d$W, as.matrix(d[, c(mods, "ST001D01T", "okul_escs",
"SC013Q01TA", "SC001Q01TA", "ST001D01T_na", "SC013Q01TA_na",
"SC001Q01TA_na")]))
  ci0 <- as.integer(factor(d$CNT)); base <- base[, apply(base, 2,
function(v) sum(rowsum((v - ave(v, ci0))^2, ci0)) > 1e-9), drop = FALSE]
  list(d = d, Z = base, ci = as.integer(factor(d$CNT)), mods = mods)
}
kohort <- function(ad) switch(ad,
  "2018" = list(d = hz(readRDS(file.path(O, "dr_2018.rds")), ana56, kiz =
TRUE), kiz = TRUE),
  "2022" = list(d = hz(readRDS(file.path(O, "dr_2022.rds")), stres53, kiz
= TRUE), kiz = TRUE),
  "2025" = list(d = hz(readRDS(file.path(O, "dr_2025.rds")), ana56, kiz =
FALSE), kiz = FALSE))
```

```

### 10a_anket_tasarimi.R

```r

# 10a_anket_tasarimi.R | Hakem 1 madde 3, Hakem 2: anket bilincli sabit etkili regresyon (BRR-Fay, 80 yineleme)
# M1: Y ~ W + kovaryatlar + ulke sabit etkisi;  M2: M1 + W x (ESCS, ev dijital, [cinsiyet], gocmen) (SD basina)
# Agirlik: (a) PISA nihai ogrenci agirligi, (b) ulkeleri esit agirliklandiran (her ulke toplami 1)
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_Causal_Forest_/scripts/08_ortak.R")
wsd <- function(y, w) sqrt(sum(w * (y - sum(w * y) / sum(w))^2) / sum(w))

fe_fit <- function(Z, y, ci, w) {                       # FWL: agirlikli ulke ici merkezleme, sonra WLS
  M <- cbind(y, Z); tot <- rowsum(w, ci)[, 1]; cm <- rowsum(w * M, ci) / tot; Md <- M - cm[ci, , drop = FALSE]
  Zd <- Md[, -1, drop = FALSE]; drop(solve(crossprod(Zd, w * Zd), crossprod(Zd, w * Md[, 1])))
}
modelle <- function(d, kiz, ad) {
  d <- doldur(d, c("ST001D01T", "SC013Q01TA", "SC001Q01TA"))
  ci <- as.integer(factor(d$CNT)); mods <- c("ESCS", if (kiz) "kiz", "ev_dijital", "gocmen")
  zm <- scale(as.matrix(d[, mods])); colnames(zm) <- paste0("WxSD_", mods)
  base <- cbind(W = d$W, as.matrix(d[, c(mods, "ST001D01T", "okul_escs", "SC013Q01TA", "SC001Q01TA", "ST001D01T_na", "SC013Q01TA_na", "SC001Q01TA_na")]))
  base <- base[, apply(base, 2, function(v) sum(rowsum((v - ave(v, ci))^2, ci)) > 1e-9), drop = FALSE]   # ulke ici varyansi sifir olan sutunlari ayikla (ulke sabit etkisi emer)
  Z1 <- base; Z2 <- cbind(base, zm * d$W)
  ctot <- ave(d$W_FSTUWT, ci, FUN = sum)                # ulke toplami (esit ulke agirligi icin)
  agirlik <- list(PISA = list(w0 = d$W_FSTUWT, rep = function(r) d[[RW[r]]]),
                  ESIT = list(w0 = d$W_FSTUWT / ctot, rep = function(r) d[[RW[r]]] / ctot))
  sdY <- wsd(d$Y, d$W_FSTUWT); out <- list()
  for (aw in names(agirlik)) for (md in c("M1", "M2")) {
    Z <- if (md == "M1") Z1 else Z2; a <- agirlik[[aw]]
    b0 <- fe_fit(Z, d$Y, ci, a$w0); br <- sapply(1:80, function(r) fe_fit(Z, d$Y, ci, a$rep(r)))
    se <- sqrt(rowSums((br - b0)^2) / 20); keep <- c("W", grep("^WxSD_", names(b0), value = TRUE))
    out[[paste(aw, md, sep = "_")]] <- data.frame(kohort = ad, agirlik = aw, model = md, terim = keep, est = b0[keep], se = se[keep],
        lo = b0[keep] - 1.96 * se[keep], hi = b0[keep] + 1.96 * se[keep], p = 2 * pnorm(-abs(b0[keep] / se[keep])), n = nrow(d), k = length(unique(d$CNT)), sdY = sdY, row.names = NULL)
```
```

```
  }
  do.call(rbind, out)
}
sonuc <- list()
sonuc$k2018 <- modelle(hz(readRDS(file.path(O, "dr_2018.rds")), ana56,
kiz = TRUE), TRUE, "2018"); cat("2018 tamam\n");
print(subset(sonuc$k2018, terim == "W" & model == "M1"), digits = 3)
sonuc$k2022 <- modelle(hz(readRDS(file.path(O, "dr_2022.rds")), stres53,
kiz = TRUE), TRUE, "2022"); cat("2022 tamam\n")
sonuc$k2025 <- modelle(hz(readRDS(file.path(O, "dr_2025.rds")), ana56,
kiz = FALSE), FALSE, "2025"); cat("2025 tamam\n")
S <- do.call(rbind, sonuc); saveRDS(S, file.path(R1,
"a2_brr_regresyon.rds")); write.csv(S, file.path(R1,
"a2_brr_regresyon.csv"), row.names = FALSE)
print(S[S$model == "M1" & S$terim == "W", c("kohort", "agirlik", "est",
"se", "lo", "hi", "p", "n", "k")], digits = 3, row.names = FALSE)

```

10b_ulke_duzeyi.R

```r

# 10b_ulke_duzeyi.R | Hakem 1 madde 9, Hakem 2: ulke bazli iliskiler,
dagilim, bir ulke disarida birakma
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/10_regfun.R")
suppressPackageStartupMessages(library(metafor))
ulke_fit <- function(z, kiz) {
  z <- doldur(z, c("ST001D01T", "SC013Q01TA", "SC001Q01TA")); mods <-
c("ESCS", if (kiz) "kiz", "ev_dijital", "gocmen")
  X <- cbind(1, W = z$W, as.matrix(z[, c(mods, "ST001D01T", "okul_escs",
"SC013Q01TA", "SC001Q01TA", "ST001D01T_na", "SC013Q01TA_na",
"SC001Q01TA_na")]))
  X <- X[, apply(X, 2, function(v) length(unique(v)) > 1 | all(v == 1)),
drop = FALSE]
  f <- function(w) { m <- lm.wfit(X, z$Y, w); unname(m$coefficients["W"])
}
  b0 <- f(z$W_FSTUWT); br <- sapply(1:80, function(r) f(z[[RW[r]]]));
c(est = b0, se = brr_se(b0, br), n = nrow(z), schools =
length(unique(z$CNTSCHID)), p1 = wm(z$W, z$W_FSTUWT))
}
out <- list(); meta <- list()
for (ad in c("2018", "2022", "2025")) {
  k <- kohort(ad); d <- k$d
  tab <- do.call(rbind, lapply(split(d, d$CNT), function(z)
data.frame(CNT = z$CNT[1], t(ulke_fit(z, k$kiz)))))
  tab$kohort <- ad; tab$sdY <- sapply(split(d, d$CNT), function(z)
wsd(z$Y, z$W_FSTUWT))[tab$CNT]; tab <- tab[is.finite(tab$est) &
is.finite(tab$se), ]
  r <- rma(yi = tab$est, sei = tab$se, method = "REML"); pi <- predict(r)
  loo <- sapply(seq_len(nrow(tab)), function(i) coef(rma(yi = tab$est[-
i], sei = tab$se[-i], method = "REML")))
  z <- tab$est / tab$se
```

```
  meta[[ad]] <- data.frame(kohort = ad, k = nrow(tab), mu =
unname(coef(r)), se_mu = r$se, lo = r$ci.lb, hi = r$ci.ub, tau =
sqrt(r$tau2), I2 = r$I2, Q = r$QE, Qp = r$QEp,
    pi_lo = pi$pi.lb, pi_hi = pi$pi.ub, n_pos_sig = sum(z > 1.96),
n_neg_sig = sum(z < -1.96), n_pos = sum(tab$est > 0), loo_min = min(loo),
loo_max = max(loo),
    en_etkili = tab$CNT[which.max(abs(loo - coef(r)))], est_min =
min(tab$est), est_max = max(tab$est))
  out[[ad]] <- tab; cat(ad, "tamam\n"); print(meta[[ad]], digits = 3,
row.names = FALSE)
}
saveRDS(list(ulke = do.call(rbind, out), meta = do.call(rbind, meta)),
file.path(R1, "a4_ulke_duzeyi.rds")); cat("TAMAM\n")

```

10c_okul_ps.R

```r

# 10c_okul_ps.R | Hakem 1 madde 2: programi olan/olmayan okullarin
karsilastirilmasi, ortusme, egilim skoru agirliklandirmasi
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/10_regfun.R")
wvar <- function(x, w) sum(w * (x - wm(x, w))^2) / sum(w)
smd <- function(x, g, w) { ok <- !is.na(x); x <- x[ok]; g <- g[ok]; w <-
w[ok]; (wm(x[g == 1], w[g == 1]) - wm(x[g == 0], w[g == 0])) /
sqrt((wvar(x[g == 1], w[g == 1]) + wvar(x[g == 0], w[g == 0])) / 2) }
sonuc <- list()
for (ad in c("2018", "2022", "2025")) {
  k <- kohort(ad); d <- k$d; d$ozel <- as.numeric(d$SC013Q01TA == 2)
  sc <- d |> group_by(CNTSCHID) |> summarise(CNT = first(CNT), W =
first(W), sw = sum(W_FSTUWT), okul_escs = first(okul_escs), ozel =
mean(ozel, na.rm = TRUE),
          konum = mean(SC001Q01TA, na.rm = TRUE), sinif = mean(ST001D01T,
na.rm = TRUE), gocmen = mean(gocmen), ev_dijital = mean(ev_dijital), kiz
= if (k$kiz) mean(kiz) else NA_real_, .groups = "drop")
  cv <- c("okul_escs", "ozel", "konum", "sinif", "gocmen", "ev_dijital",
if (k$kiz) "kiz")
  # ulke ici (ulke ortalamasi cikarilmis) SMD
  sc_adj <- sc; for (v in cv) sc_adj[[v]] <- sc[[v]] - ave(sc[[v]],
sc$CNT, FUN = function(x) mean(x, na.rm = TRUE))
  # egilim skoru: okul duzeyi, ulke sabit etkili
  scz <- doldur(as.data.frame(sc), c("ozel", "konum")); scz$cnt <-
factor(scz$CNT)
  ps <- glm(W ~ okul_escs + ozel + ozel_na + konum + konum_na + cnt, data
= scz, weights = sw / mean(sw), family = quasibinomial())
  p <- predict(ps, type = "response"); sc$p_ham <- p; sc$p <-
pmin(pmax(p, .05), .95); sc$ipw <- ifelse(sc$W == 1, 1 / sc$p, 1 / (1 -
sc$p))
  ort <- data.frame(kohort = ad, okul = nrow(sc), prog_okul = mean(sc$W),
p_dis_005_095 = wm(p < .05 | p > .95, sc$sw),
        p_q_prog = I(list(quantile(p[sc$W == 1], c(0, .05, .5, .95,
1)))), p_q_yok = I(list(quantile(p[sc$W == 0], c(0, .05, .5, .95, 1)))))
```

```
  smd_tab <- do.call(rbind, lapply(cv, function(v) data.frame(kohort =
ad, degisken = v,
        smd_ham = smd(sc[[v]], sc$W, sc$sw), smd_ulke_ici =
smd(sc_adj[[v]], sc$W, sc$sw), smd_ipw = smd(sc_adj[[v]], sc$W, sc$sw *
sc$ipw))))
  # ogrenci duzeyi: IPW x PISA agirligi, M1 tasarimi, BRR
  tz <- tasarim(d, k$kiz); ipw_s <- sc$ipw[match(d$CNTSCHID,
sc$CNTSCHID)]
  b0 <- fe_fit(tz$Z, d$Y, tz$ci, d$W_FSTUWT * ipw_s); br <- sapply(1:80,
function(r) fe_fit(tz$Z, d$Y, tz$ci, d[[RW[r]]] * ipw_s)); se <-
brr_se(b0["W"], br["W", ])
  b0n <- fe_fit(tz$Z, d$Y, tz$ci, d$W_FSTUWT)
  est <- data.frame(kohort = ad, ipw_est = unname(b0["W"]), ipw_se = se,
ipw_lo = unname(b0["W"] - 1.96 * se), ipw_hi = unname(b0["W"] + 1.96 *
se), duz_est = unname(b0n["W"]), sdY = wsd(d$Y, d$W_FSTUWT), n = nrow(d))
  sonuc[[ad]] <- list(ort = ort, smd = smd_tab, est = est); cat(ad,
"tamam\n"); print(est, digits = 3, row.names = FALSE); print(smd_tab,
digits = 2, row.names = FALSE); print(ort[, 1:4], digits = 3, row.names =
FALSE)
}
saveRDS(sonuc, file.path(R1, "a6_okul_ps.rds")); cat("TAMAM\n")

```

11_h4_kontrast.R

```r

# 11_h4_kontrast.R | Hakem 1 madde 6 + madde 7: H4 dogrudan
karsilastirma; 2025'te bagimsiz BLP
# Ortak orneklem: uc sonucu da gozlenen 2025 ogrencileri (51 ulke). Yon
hizalama: yuksek = elverisli
#   yasam doyumu (+), baski ve kaygi (-1 ile carpilir). Kontrast:
yakin(hizali) - yasam doyumu
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/10_regfun.R")
d <- hz(readRDS(file.path(O, "dr_2025.rds")), ana56, kiz = FALSE)
d <- d[!is.na(d$ST322Q06JA) & !is.na(d$ST322Q07JA), ]; cat("Ortak
orneklem n =", nrow(d), "| ulke =", length(unique(d$CNT)), "| okul =",
length(unique(d$CNTSCHID)), "\n")
z <- function(v) as.numeric(scale(v))
Yl <- list(YD = z(d$Y), BASKI = -z(d$ST322Q06JA), KAYGI = -
z(d$ST322Q07JA))     # hizali (yuksek = elverisli)
cl <- as.integer(factor(d$CNTSCHID)); w <- d$W_FSTUWT
# --- 1) Orman tabanli: AIPW skorlarindan kume-saglam kovaryans ---
cfs <- lapply(Yl, function(y) orman(d, ana56, y = y, kiz = FALSE))
sk <- lapply(cfs, function(f) as.numeric(get_scores(f)))
ate_grf <- lapply(cfs, average_treatment_effect)
ate_el <- function(g) { tau <- sum(w * g) / sum(w); S <- rowsum(w * (g -
tau), cl)[, 1]; c(est = tau, se = sqrt(sum(S^2)) / sum(w)) }
cat("Dogrulama (grf vs el hesabi):\n"); for (n in names(sk)) cat(n,
"grf:", round(ate_grf[[n]], 5), "| el:", round(ate_el(sk[[n]]), 5), "\n")
kontrast <- function(a, b) ate_el(sk[[a]] - sk[[b]])
```

```
orman_k <- rbind(BASKI_YD = kontrast("BASKI", "YD"), KAYGI_YD =
kontrast("KAYGI", "YD"), YAKIN_ORT_YD = ate_el((sk$BASKI + sk$KAYGI) / 2
- sk$YD), BASKI_KAYGI = kontrast("BASKI", "KAYGI"))
orman_k <- data.frame(kontrast = rownames(orman_k), orman_k, row.names =
NULL); orman_k$lo <- orman_k$est - 1.96 * orman_k$se; orman_k$hi <-
orman_k$est + 1.96 * orman_k$se
orman_k$p <- 2 * pnorm(-abs(orman_k$est / orman_k$se)); cat("\nOrman
(AIPW) kontrastlari, SD birimi, elverisli yon +:\n"); print(orman_k,
digits = 3, row.names = FALSE)
# --- 2) BRR tabanli regresyon (ayni orneklem), katsayi ve kontrast ---
tz <- tasarim(d, FALSE)
beta <- function(y, wt) fe_fit(tz$Z, y, tz$ci, wt)["W"]
b0 <- sapply(Yl, beta, wt = w); br <- sapply(1:80, function(r) sapply(Yl,
beta, wt = d[[RW[r]]]))
cc <- list(BASKI_YD = c(1, 0, -1)[c(2, 1, 3)] , KAYGI_YD = NULL)
vec <- function(a, b) { v <- setNames(numeric(3), names(Yl)); v[a] <- 1;
v[b] <- -1; v }
V <- list(BASKI_YD = vec("BASKI", "YD"), KAYGI_YD = vec("KAYGI", "YD"),
YAKIN_ORT_YD = c(YD = -1, BASKI = .5, KAYGI = .5), BASKI_KAYGI =
vec("BASKI", "KAYGI"))
brr_k <- do.call(rbind, lapply(names(V), function(n) { e0 <- sum(V[[n]] *
b0); er <- colSums(V[[n]] * br); se <- brr_se(e0, er);
data.frame(kontrast = n, est = e0, se = se, lo = e0 - 1.96 * se, hi = e0
+ 1.96 * se, p = 2 * pnorm(-abs(e0 / se))) }))
brr_b <- data.frame(sonuc = names(Yl), est = b0, se =
sapply(seq_along(b0), function(i) brr_se(b0[i], br[i, ])), row.names =
NULL)
cat("\nBRR regresyon katsayilari (hizali SD):\n"); print(brr_b, digits =
3, row.names = FALSE); cat("\nBRR kontrastlari:\n"); print(brr_k, digits
= 3, row.names = FALSE)
# --- 3) 2025'te bagimsiz BLP (ESCS, ev dijital, gocmen), tam 51 ulke,
yasam doyumu ---
d2 <- hz(readRDS(file.path(O, "dr_2025.rds")), ana56, kiz = FALSE); c25
<- orman(d2, ana56, kiz = FALSE)
blp25 <- best_linear_projection(c25, scale(d2[, c("ESCS", "ev_dijital",
"gocmen")])); cat("\n2025 BLP (yasam doyumu, puan/SD):\n"); print(blp25,
digits = 3)
kal25 <- test_calibration(c25); print(kal25); ate25 <-
average_treatment_effect(c25)
saveRDS(list(n = nrow(d), orman_k = orman_k, brr_k = brr_k, brr_b =
brr_b, ate_grf = ate_grf, blp25 = blp25, kal25 = kal25, ate25 = ate25,
n25 = nrow(d2)), file.path(R1, "a5_h4_kontrast_blp25.rds"));
cat("TAMAM\n")

```

12_orman_esit_ulke.R

```r

# 12_orman_esit_ulke.R | Hakem 1 madde 3: ulkeleri esit agirliklandiran
orman (ATE, BLP, kalibrasyon) ve 2025 RATE
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/10_regfun.R")
```

```
esit <- function(d) d$W_FSTUWT / ave(d$W_FSTUWT, d$CNT, FUN = sum)
sonuc <- list()
for (ad in c("2018", "2022", "2025")) {
  k <- kohort(ad); d <- k$d; set <- if (ad == "2022") stres53 else ana56;
w <- esit(d) * nrow(d) / length(unique(d$CNT)) / mean(esit(d) * nrow(d) /
length(unique(d$CNT)))
  cf <- orman(d, set, kiz = k$kiz, w = w)
  mods <- c("ESCS", "ev_dijital", if (k$kiz) "kiz", "gocmen")
  r <- list(n = nrow(d), k = length(unique(d$CNT)), ate =
average_treatment_effect(cf), blp = best_linear_projection(cf, scale(d[,
mods])), kal = test_calibration(cf),
            neg = mean(predict(cf)$predictions < 0), sdY_esit = { m <-
sum(w * d$Y) / sum(w); sqrt(sum(w * (d$Y - m)^2) / sum(w)) })
  if (ad == "2025") { d18 <- hz(readRDS(file.path(O, "dr_2018.rds")),
ana56, kiz = FALSE); w18 <- esit(d18); w18 <- w18 / mean(w18)
    c18 <- orman(d18, ana56, kiz = FALSE, w = w18); r$rate <-
rank_average_treatment_effect(cf, priorities = predict(c18, Xf(d, ana56,
kiz = FALSE))$predictions) }
  sonuc[[ad]] <- r; cat(ad, "tamam\n"); print(r$ate); print(r$blp);
rm(cf); gc()
}
saveRDS(sonuc, file.path(R1, "a2_orman_esit_ulke.rds")); cat("TAMAM\n")
```

13_esdegerlik.R

```r
# 13_esdegerlik.R | Hakem 1 madde 5, Hakem 2: CI'nin disladigi buyukluk +
KESFEDICI TOST (SESOI veri gorulmeden belirlenmedi)
source("C:/Users/CROSSHAIR/Desktop/PROJECTS/ARTICLES/Digital_Resilience_C
ausal_Forest_/scripts/08_ortak.R")
sdY <- c("2018" = NA, "2022" = NA, "2025" = NA)      #
a2_brr_regresyon.rds icinde agirlikli SD var
S <- readRDS(file.path(R1, "a2_brr_regresyon.rds")); sdY[] <-
sapply(names(sdY), function(k) S$sdY[S$kohort == k][1])
a <- readRDS(file.path(O, "sonuc_kesif_tekrar.rds")); b <-
readRDS(file.path(O, "sonuc_duyarlilik.rds")); h <- readRDS(file.path(O,
"sonuc_H3_duzeltilmis.rds"))
t4 <- read.csv(file.path(O, "tablo4_H4_51ulke.csv"), fileEncoding = "UTF-
8")
sat <- function(id, kohort, yontem, est, se, n, k, birim = "puan")
data.frame(id = id, kohort = kohort, yontem = yontem, est = est, se = se,
n = n, k = k, birim = birim, stringsAsFactors = FALSE)
L <- list(
  sat("F18", "2018", "Nedensel orman (birincil, PISA agirligi)",
a$H1[["estimate"]], a$H1[["std.err"]], a$n18, 56),
  sat("F22", "2022", "Nedensel orman (PISA agirligi)",
b$d2022$ate[["estimate"]], b$d2022$ate[["std.err"]], b$d2022$n, 52),
  sat("F25", "2025", "Nedensel orman (birincil, PISA agirligi)",
h$ate25[["estimate"]], h$ate25[["std.err"]], h$n25, 51),
```

```
  sat("F18S", "2018", "Orman, 6 yuksek yanitsizlikli ulke cikarildi (2018
orneklemi)", b$yanitsizlik$ate[["estimate"]],
b$yanitsizlik$ate[["std.err"]], b$yanitsizlik$n, b$yanitsizlik$ulke))
for (k in c("2018", "2022", "2025")) for (w in c("PISA", "ESIT")) { r <-
S[S$kohort == k & S$agirlik == w & S$model == "M1" & S$terim == "W", ]
  L[[length(L) + 1]] <- sat(paste0("R", k, w), k, paste0("Anket bilincli
regresyon, ", ifelse(w == "PISA", "PISA agirligi", "esit ulke
agirligi")), r$est, r$se, r$n, r$k) }
for (f in c("A", "B", "IPW")) { p <- file.path(R1, paste0("a1_orman_", f,
".rds")); if (file.exists(p)) { x <- readRDS(p); L[[length(L) + 1]] <-
sat(paste0("M", f), "2025", c(A = "Orman, onceden belirlenen 6 ulke
cikarildi (2025)", B = "Orman, sonuc eksikligi > %20 olan 11 ulke
cikarildi (2025)", IPW = "Orman, yanitlama olasiligi ters agirligi
(2025)")[[f]], x$ate[["estimate"]], x$ate[["std.err"]], x$n, x$k) } }
p <- file.path(R1, "a2_orman_esit_ulke.rds"); if (file.exists(p)) { x <-
readRDS(p); for (k in names(x)) L[[length(L) + 1]] <- sat(paste0("FE",
k), k, "Nedensel orman, esit ulke agirligi", x[[k]]$ate[["estimate"]],
x[[k]]$ate[["std.err"]], x[[k]]$n, x[[k]]$k) }
p <- file.path(R1, "a6_okul_ps.rds"); if (file.exists(p)) { x <-
readRDS(p); for (k in names(x)) L[[length(L) + 1]] <- sat(paste0("P", k),
k, "Egilim skoru (IPW) ile agirlikli regresyon", x[[k]]$est$ipw_est,
x[[k]]$est$ipw_se, x[[k]]$est$n, NA) }
p <- file.path(R1, "a4_ulke_duzeyi.rds"); if (file.exists(p)) { x <-
readRDS(p)$meta; for (i in seq_len(nrow(x))) L[[length(L) + 1]] <-
sat(paste0("U", x$kohort[i]), x$kohort[i], "Ulke duzeyi rastgele etkili
meta-analiz (ortalama)", x$mu[i], x$se_mu[i], NA, x$k[i]) }
E <- do.call(rbind, L)
E$sd <- as.numeric(sdY[E$kohort]); E$est_sd <- E$est / E$sd; E$se_sd <-
E$se / E$sd
E$lo95 <- E$est_sd - 1.96 * E$se_sd; E$hi95 <- E$est_sd + 1.96 * E$se_sd;
E$disla <- pmax(abs(E$lo95), abs(E$hi95))
E$p_nol <- 2 * pnorm(-abs(E$est / E$se))
tost <- function(est, se, d) max(1 - pnorm((est + d) / se), pnorm((est -
d) / se))
E$tost_p05 <- mapply(tost, E$est_sd, E$se_sd, MoreArgs = list(d = .05));
E$tost_p10 <- mapply(tost, E$est_sd, E$se_sd, MoreArgs = list(d = .10))
E$dmin <- abs(E$est_sd) + qnorm(.95) * E$se_sd            # TOST'un alpha
= .05'te esdegerlik ilan edecegi en kucuk simetrik sinir (SD)
# H4: yakin sonuclar zaten SD biriminde (elverisli yon icin isaret
cevrilir)
H4 <- data.frame(sonuc = c("Yasam doyumu", "Baski (ters)", "Kaygi
(ters)"), est_sd = c(t4$Tahmin[1], -t4$Tahmin[2], -t4$Tahmin[3]), se_sd =
t4$SE[1:3])
H4$lo95 <- H4$est_sd - 1.96 * H4$se_sd; H4$hi95 <- H4$est_sd + 1.96 *
H4$se_sd; H4$disla <- pmax(abs(H4$lo95), abs(H4$hi95))
H4$tost_p05 <- mapply(tost, H4$est_sd, H4$se_sd, MoreArgs = list(d =
.05)); H4$tost_p10 <- mapply(tost, H4$est_sd, H4$se_sd, MoreArgs = list(d
= .10)); H4$dmin <- abs(H4$est_sd) + qnorm(.95) * H4$se_sd
saveRDS(list(E = E, H4 = H4, sdY = sdY), file.path(R1,
"a3_esdegerlik.rds")); options(width = 220, digits = 3); print(E[,
c("id", "yontem", "est", "se", "est_sd", "lo95", "hi95", "disla",
"tost_p05", "tost_p10", "dmin")], row.names = FALSE); print(H4, row.names
= FALSE)
```

```
```