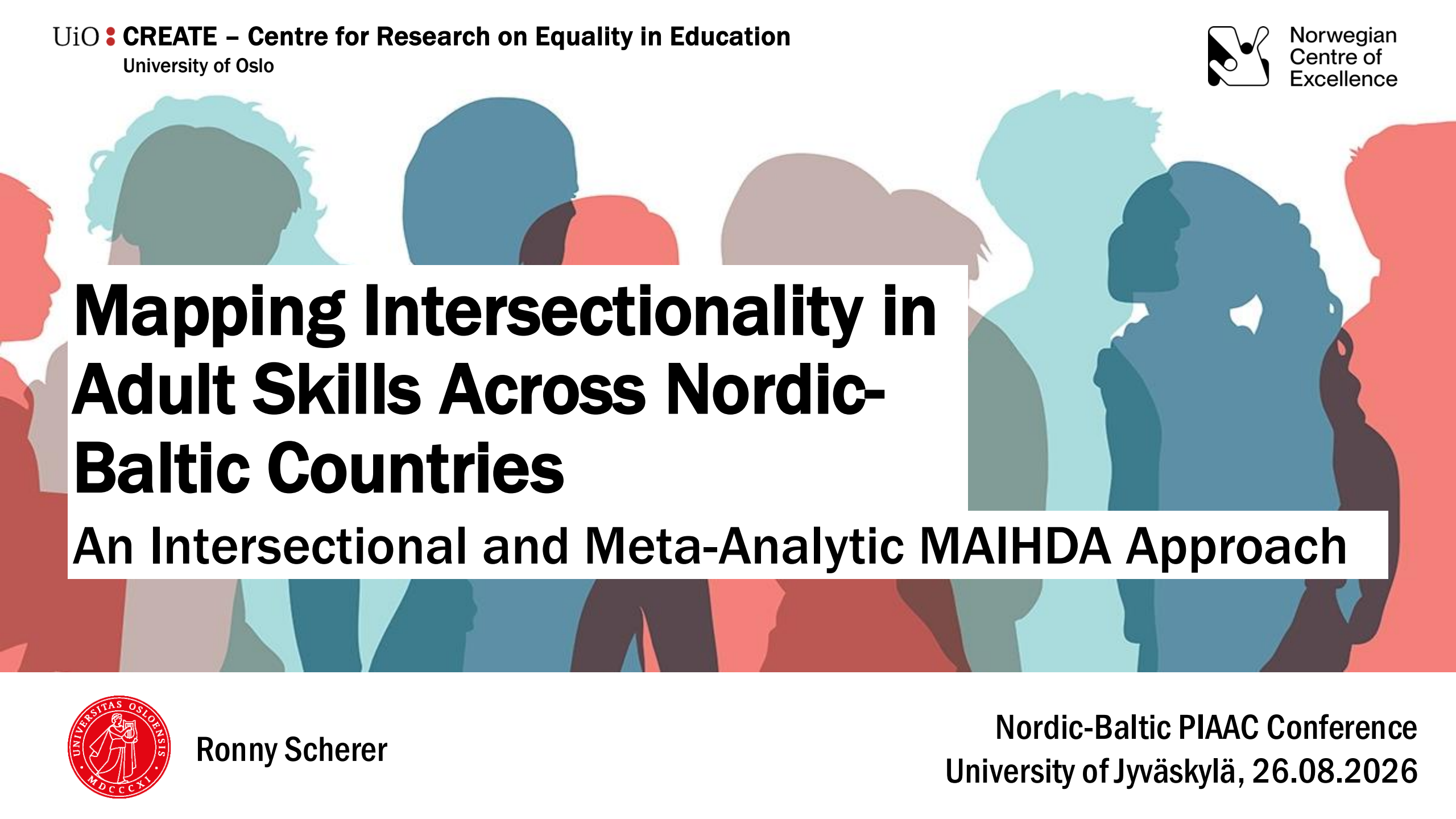




Mapping Intersectionality in Adult Skills Across Nordic- Baltic Countries

An Intersectional and Meta-Analytic MAIHDA Approach



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Adult skill gaps: One-axis-at-a-time

Gender, age, migration background, education, parental education, etc. — each has an **independent**, well-established literature as a driver of **adult skill inequality**.

Reporting and mapping of such inequalities (e.g., mean differences by gender, correlations with SES) often **one-axis-at-a-time**.

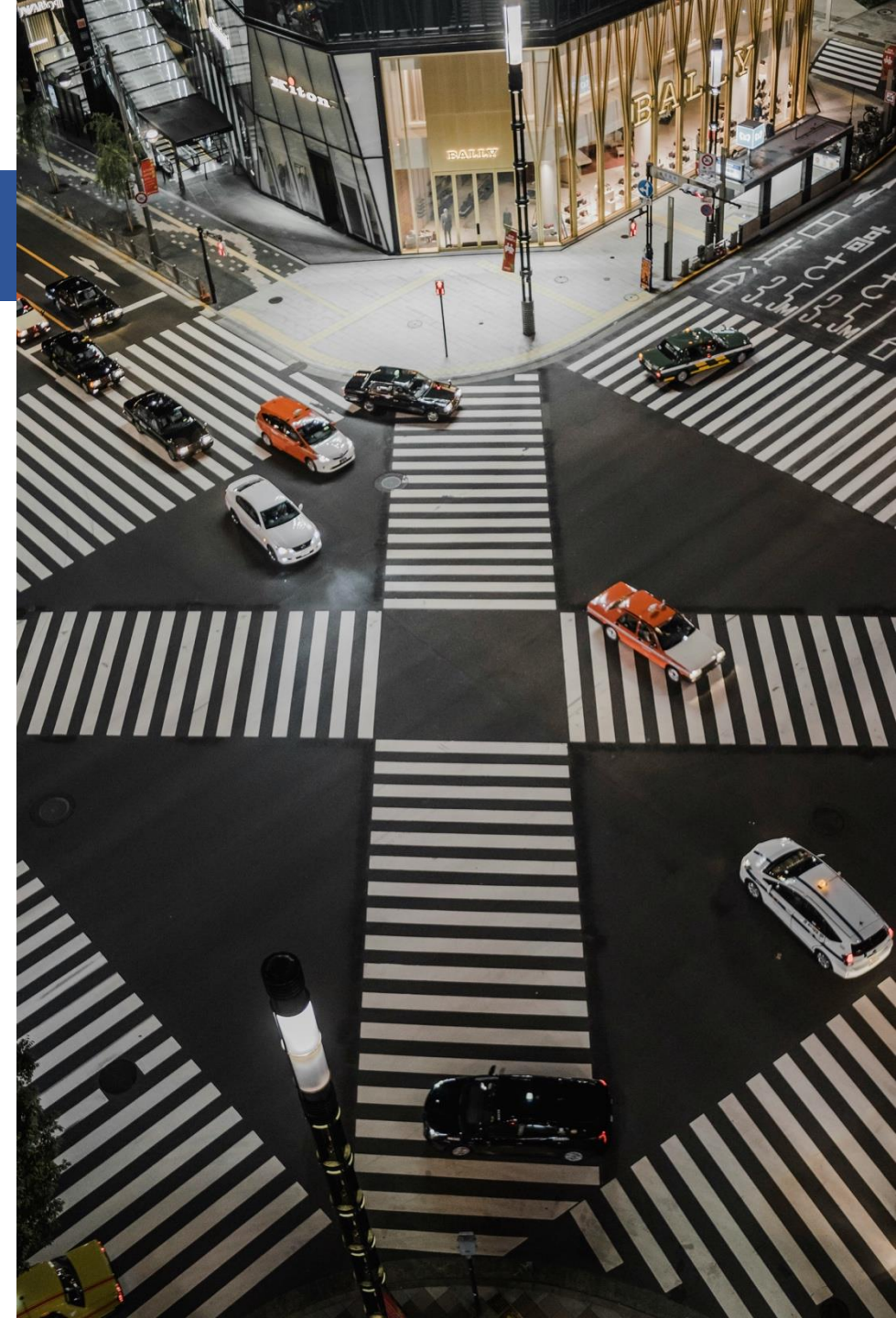
Keller et al. (2023), <https://doi.org/10.1007/s10648-023-09733-5>
OECD (2024), <https://doi.org/10.1787/b263dc5d-en>



Social positions interact

- **Intersectionality**: Being at the intersection of two disadvantaged categories is not simply the sum of two separate penalties.
- Reframes the question from “how big is the gender gap” to “**for whom** is the gender gap largest”
- A **more realistic**, not just more complex, account of stratification

Crenshaw (1989), <https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1052&context=ucf>
McCall (2005), <https://doi.org/10.1086/426800>
Bauer (2014), <https://doi.org/10.1016/j.socscimed.2014.03.022>



Goals of this study

Core substantive aims:

- 1 Quantify **how much adult skill disadvantage** is structured by **five intersecting characteristics** (gender × age cohort × migration background × own education × parental education, 32 strata) across 30 PIAAC Cycle 2 countries and **decompose that disadvantage** into what is additive vs. genuinely intersectional.
- 2 Test whether national development, gender equality, income inequality, and wealth **explain cross-country differences**.



Data and Measures

Dataset: OECD Programme for the International Assessment of Adult Competencies (PIAAC), Cycle 2. 30 participating countries analyzed (NLD excluded).

- **Sample size range:** $n=3,103$ (Portugal) to 11,607 (Canada) respondents per country
- **Nordic-Baltic focal countries:** DNK, EST, FIN, LVA, LTU, NOR, SWE
- **Outcomes:** Numeracy, Literacy, Adaptive Problem Solving (10 PVs)
- **Country-level variables:**
 - GII (UNDP Gender Inequality Index)
 - GGGI (WEF Global Gender Gap Index)
 - Gini coefficient
 - Palma ratio
 - GDP per capita (PPP)
 - Human Development Index (HDI)
 - Net migration rate (per 1,000 population)

Data and Measures

Strata variables

$2 \text{ (gender)} \times 2 \text{ (cohort)} \times 2 \text{ (migrant)} \times 2 \text{ (education)} \times 2 \text{ (parental education)} = 32 \text{ strata}$

Variable	Category 0	Category 1
Gender	Man	Women
Age cohort	45-65 (older)	16-44 (younger)
Migration background	Native-born	Migrant (1 st or 2 nd generation)
Own education	Non-tertiary (ISCED 0-4)	Tertiary (ISCED 5-8)
Parental education	Neither parent tertiary	At least one parent tertiary

Missing data: 10 PV × 20 imputation via mice (predictive mean matching), except for zero- and very-small strata cells

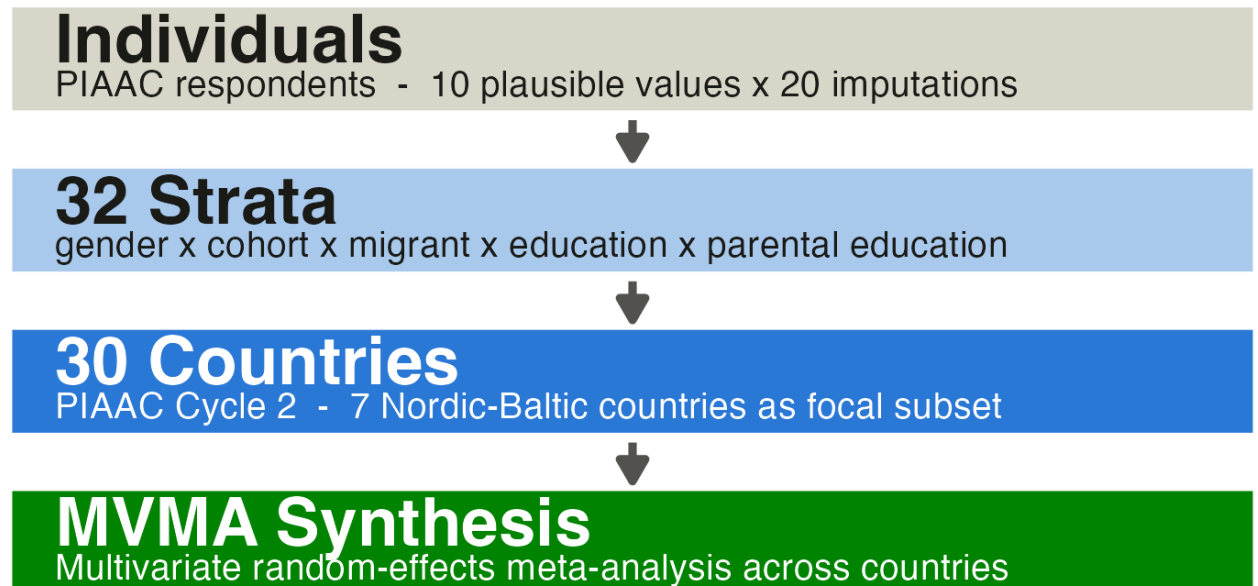
Methodological Approach: I-MAIHDA & MVMA

Two-stage approach:

1. Effect size generation via **Intersectional Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (I-MAIHDA)**
2. Effect size synthesis and moderation via **Multivariate Meta-Analysis (MVMA)**

From Individuals to a 30-Country Synthesis

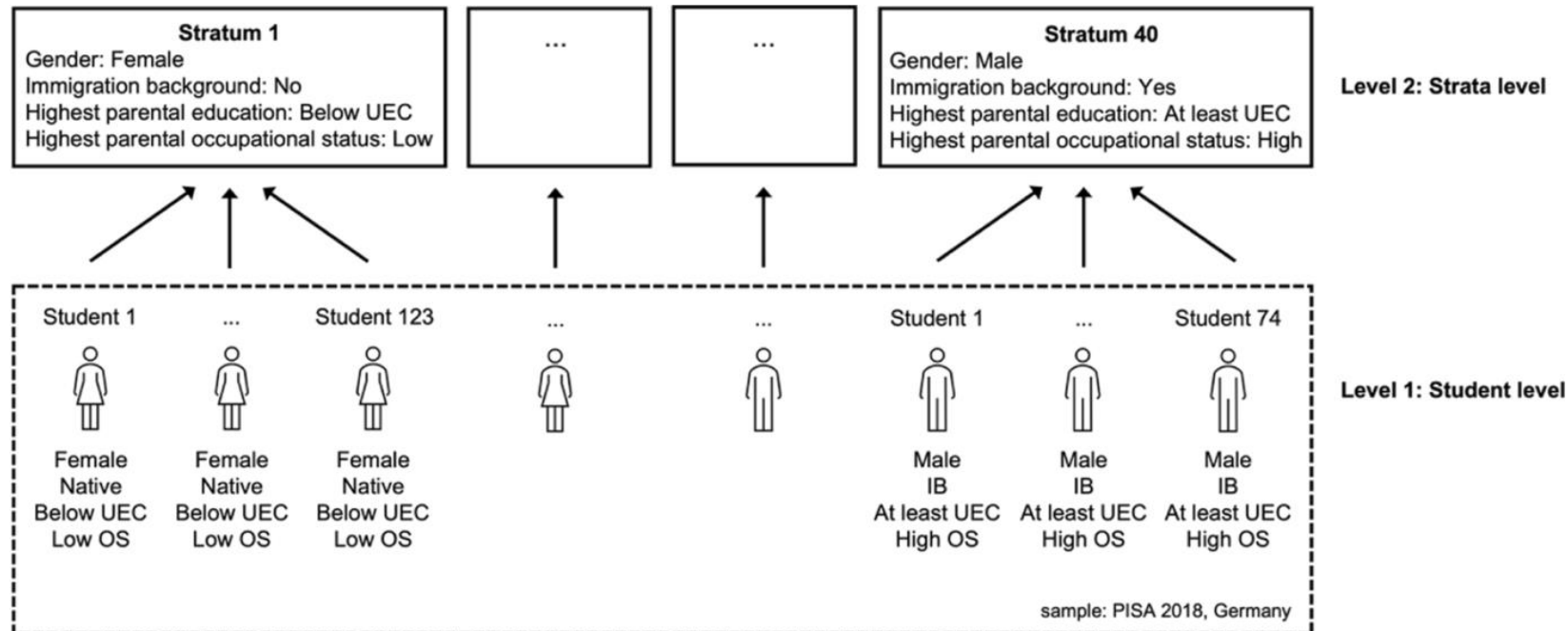
I-MAIHDA nests individuals within intersectional strata, fit per country, then pooled across 30 countries via multivariate meta-analysis (MVMA).



Methodological Approach: I-MAIHDA & MVMA

Intersectional Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (I-MAIHDA)

Evans et al. (2024), <https://doi.org/10.1016/j.ssmph.2024.101664>



Keller et al. (2023), <https://doi.org/10.1007/s10648-023-09733-5>

Methodological Approach: I-MAIHDA & MVMA

Three Effect Sizes

Variance Partition Coefficient (**VPC**)

Share of total individual-level outcome variance that lies between the 32 intersectional strata

Inverse Proportion Change in Variance (**1-PCV**)

Share of that between-stratum variance left unexplained after adding the five characteristics as additive main effects

Intersectional Variance Partition Coefficient (**iVPC**)

Share of total variance due to genuine, non-additive intersectionality, rescaled onto the total-variance scale

$$\mathbf{iVPC = VPC \times (1-PCV)}$$

Multivariate meta-analytic modelling (MVMA)

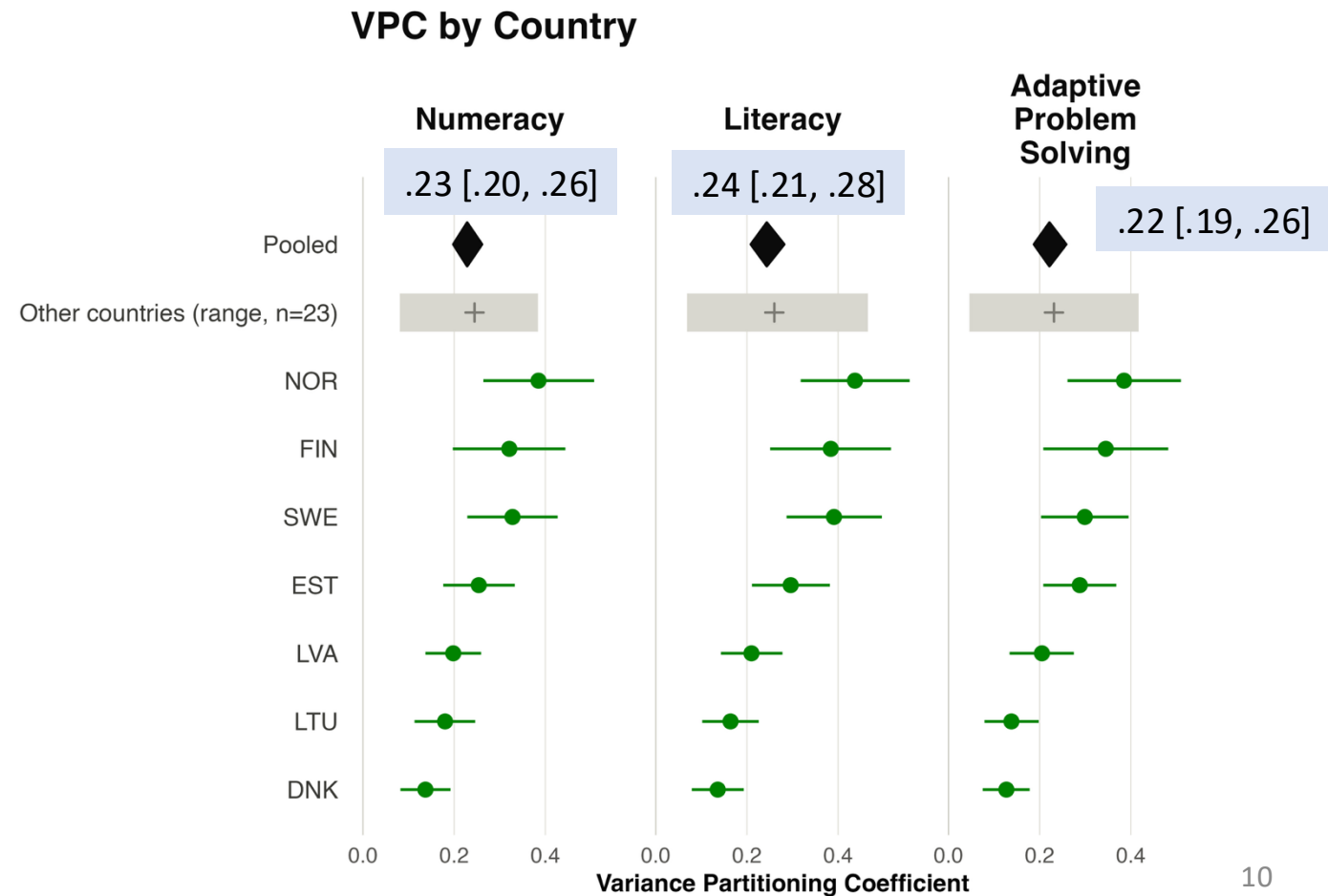
Multivariate random-effects models (multiple correlated outcomes) and moderator extensions

Most disadvantage is additive

Cross-country variation in overall stratification

Across all countries:
Substantial stratification
Domain-generalizability in effect sizes

Nordic-Baltic countries:
Large variation in stratification
($I^2 = 94-97\%$)



Most disadvantage is additive

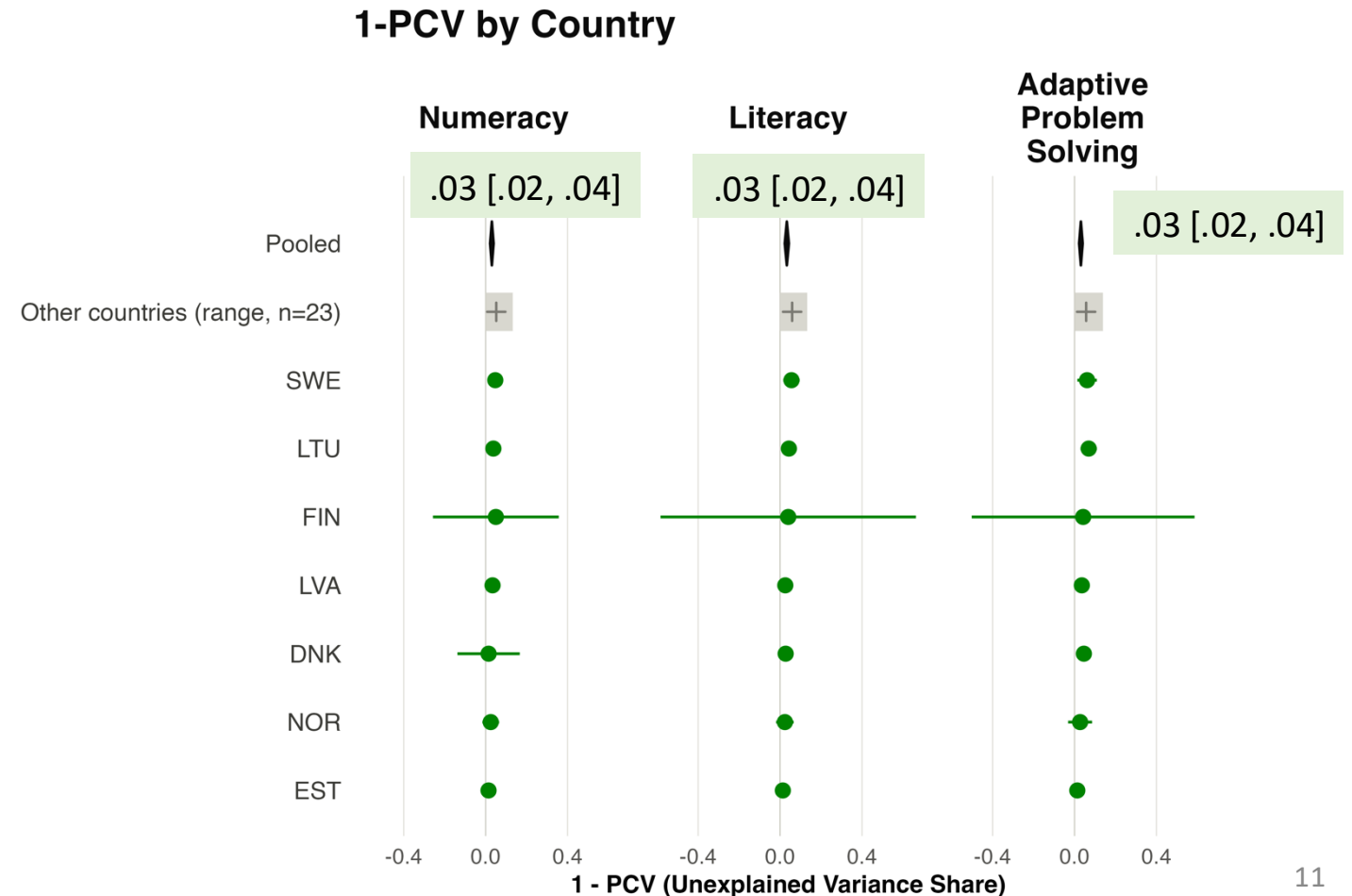
Cross-country variation in non-additive stratification

Across all countries:

Small but real degree of non-additive stratification
Domain-general in effect sizes

Nordic-Baltic countries:

Large variation in stratification
($I^2 = 64-75\%$)



Most disadvantage is additive

Cross-country variation in genuine intersectionality

Across all countries:

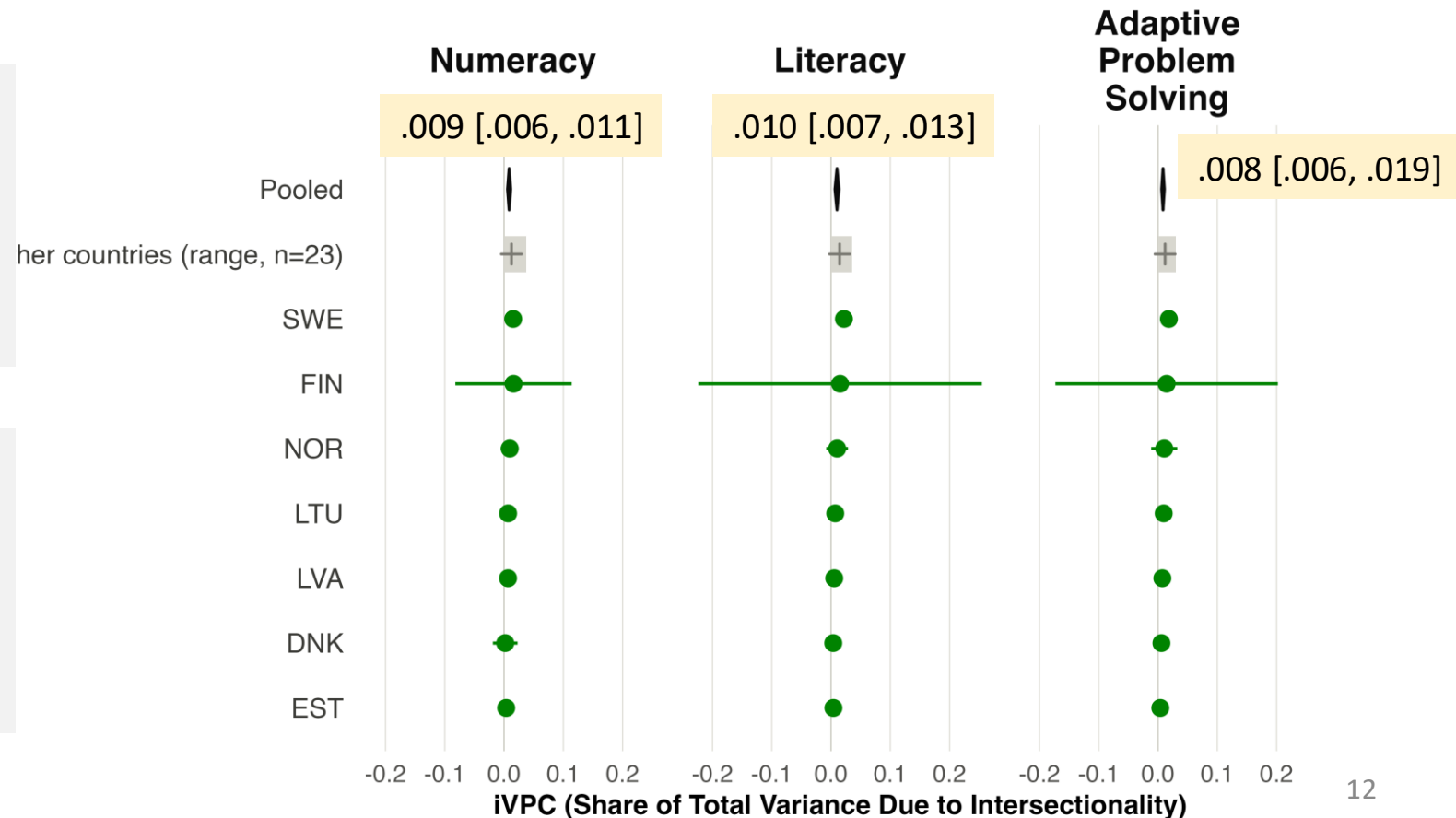
Small but real degree of intersectionality

Domain-generalty in effect sizes

Nordic-Baltic countries:

Genuine intersectionality for Lithuania, Latvia, and Sweden; Denmark (LIT & APS)

iVPC by Country



Nordic-Baltic countries do not form a block

Most stratified:

Japan (.42), Norway (.40), Belgium (.37), Finland (.35), Sweden (.34).

Least stratified:

Slovakia (.07), Poland (.08), Croatia (.08), Denmark (.13), Lithuania (.16)

Most intersectionally stratified:

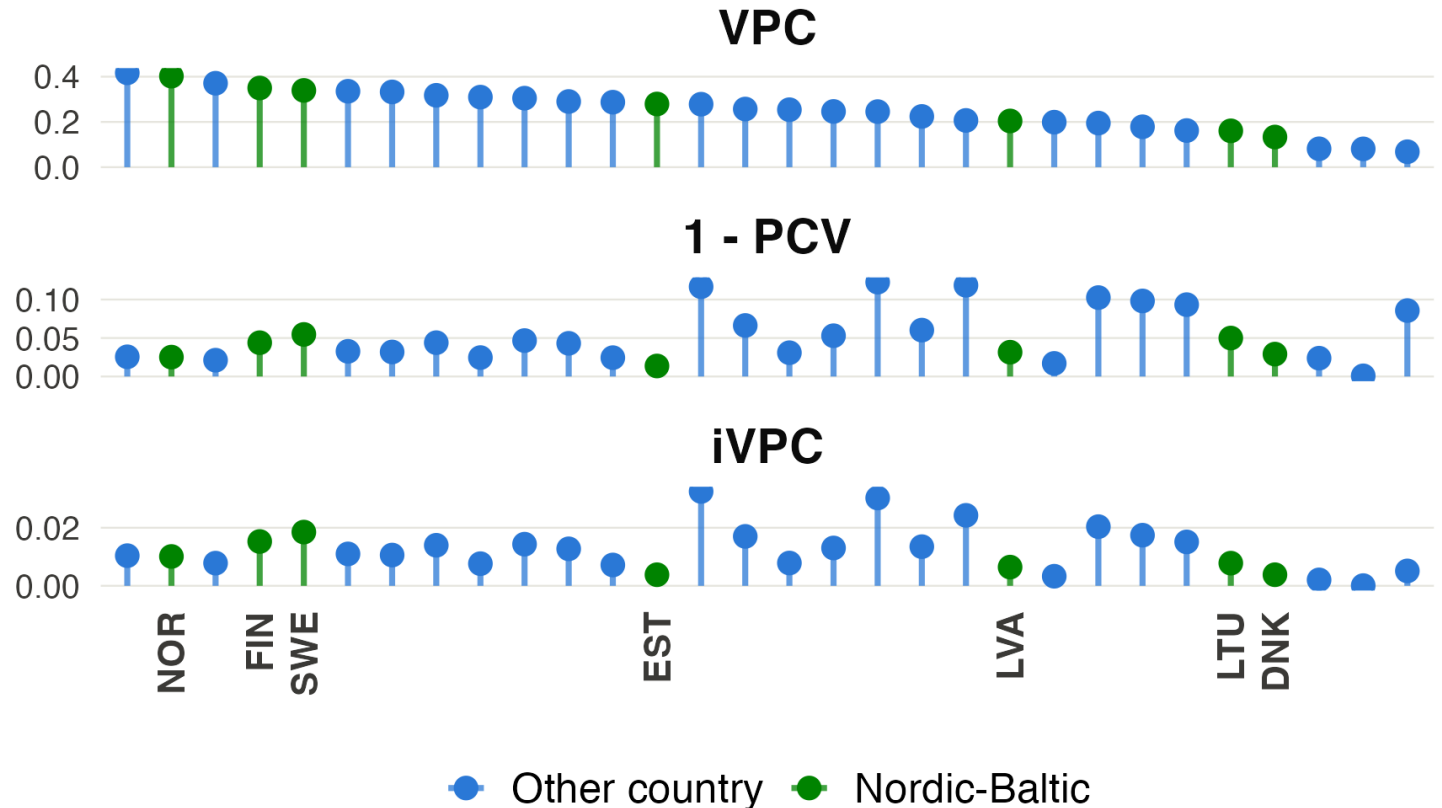
Chile (.033), Singapore (.030), New Zealand (.024), Israel (.020), Sweden (.019)

Least intersectionally stratified:

Poland (.0001), Croatia (.002), Spain (.003), Estonia (.004), Denmark (.004)

VPC, 1-PCV, iVPC by Country

Country average across domains, same order in all 3 panels (independent y-scales).



High- and Low-Performing Strata

Top strata:

Native-born, tertiary-educated, at least one tertiary-educated parent

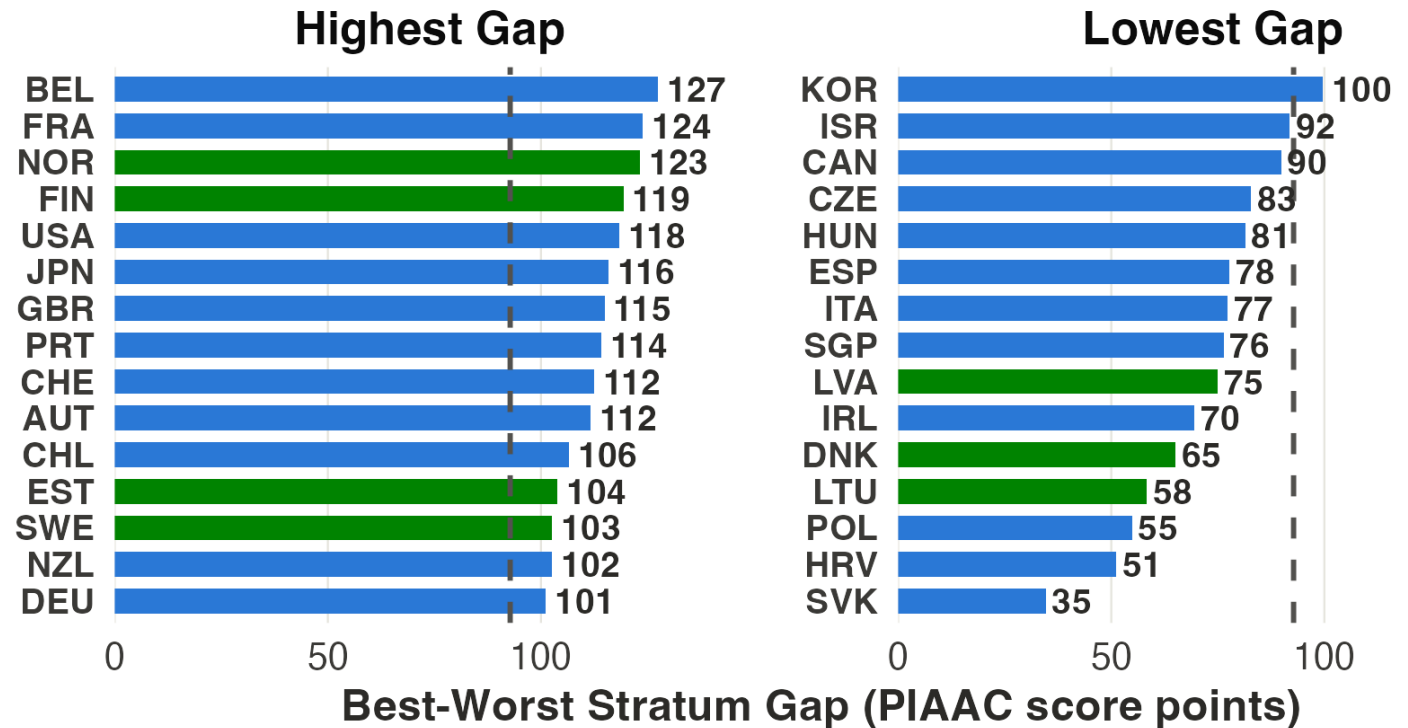
Bottom strata:

Migrant, non-tertiary educated

Own education defines the extreme stratum in 100% of countries; migrant status in 87%.

Who's at the Top, Who's at the Bottom

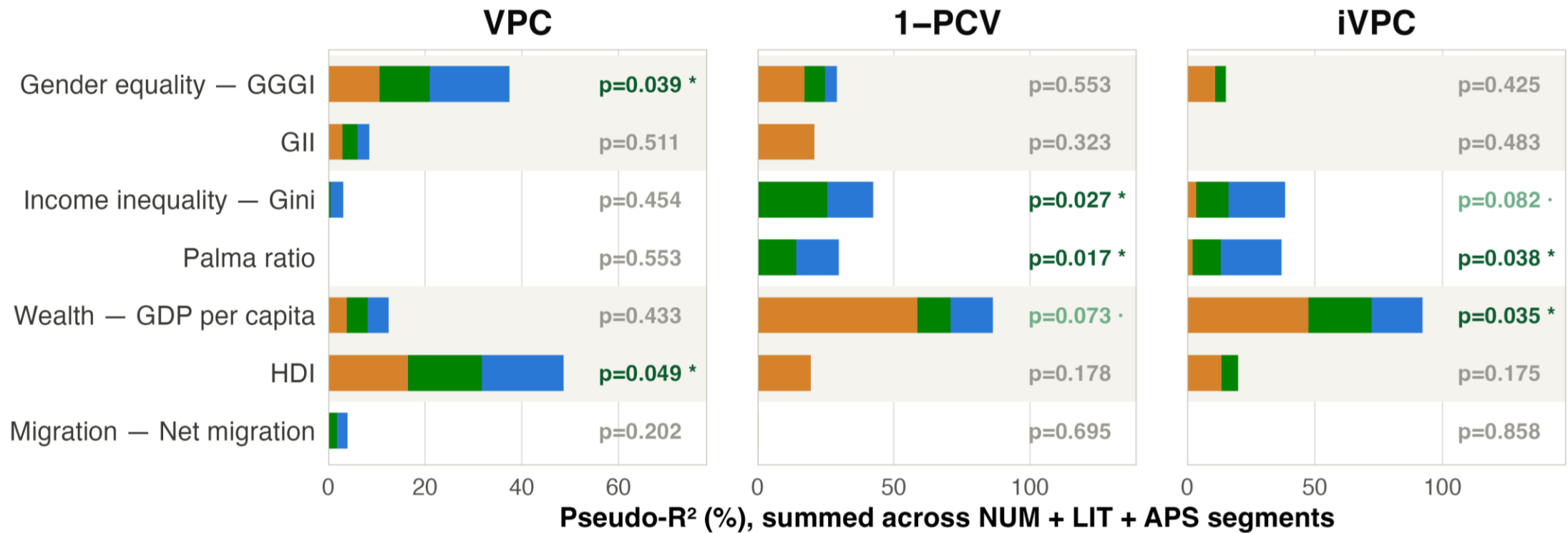
Gap between best/worst of the 32 strata, avg. across Num/Lit/APS. Dashed line = mean (93 pts).



Other country Nordic-Baltic

Country-Level Moderators

All country-level characteristics, all three effect sizes



Mixed-effects meta-regression model
with cluster-robust standard errors

Outcome domain Numeracy Literacy Adaptive Problem Solving

Some Reflections

Substantive Findings

- Skill disadvantage between strata **is substantial, and most of it is additive.**
- The extremes are defined by **education (100% of countries) and migrant status (87%);** gender/cohort/parental education shape gap size, not who is at the top/bottom.
- Consistent profile across countries: native-born + tertiary-educated + tertiary-educated parent (top) vs. migrant + non-tertiary (bottom)
- National equality and development indicators only explain moderate amount of cross-country heterogeneity
- Different moderators for VPC vs. 1-PCV/iVPC: **how stratified and how intersectional a country respond to different national conditions**
- Plausible reading: Disadvantage does not shrink as countries develop or close gender gaps—it may relocate to other strata



Thank You.

Appendix

Some Reflections

Methodological Approach

- I-MAIHDA: Partial pooling possible but not fully optimal due to small strata cells
- Substantively meaningful but different effect sizes (VPC, 1-PCV, iVPC)
- Valuable combination with MVMA for cross-country pooling and heterogeneity

Methodological Approach: I-MAIHDA & MVMA

Intersectional Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (I-MAIHDA)

Evans et al. (2024), <https://doi.org/10.1016/j.ssmph.2024.101664>

- Treat intersectional strata as levels
- Within- and between-strata variance partition
- Quantified variance explained by additive effects

Two Models

Model 1 (Null Model)

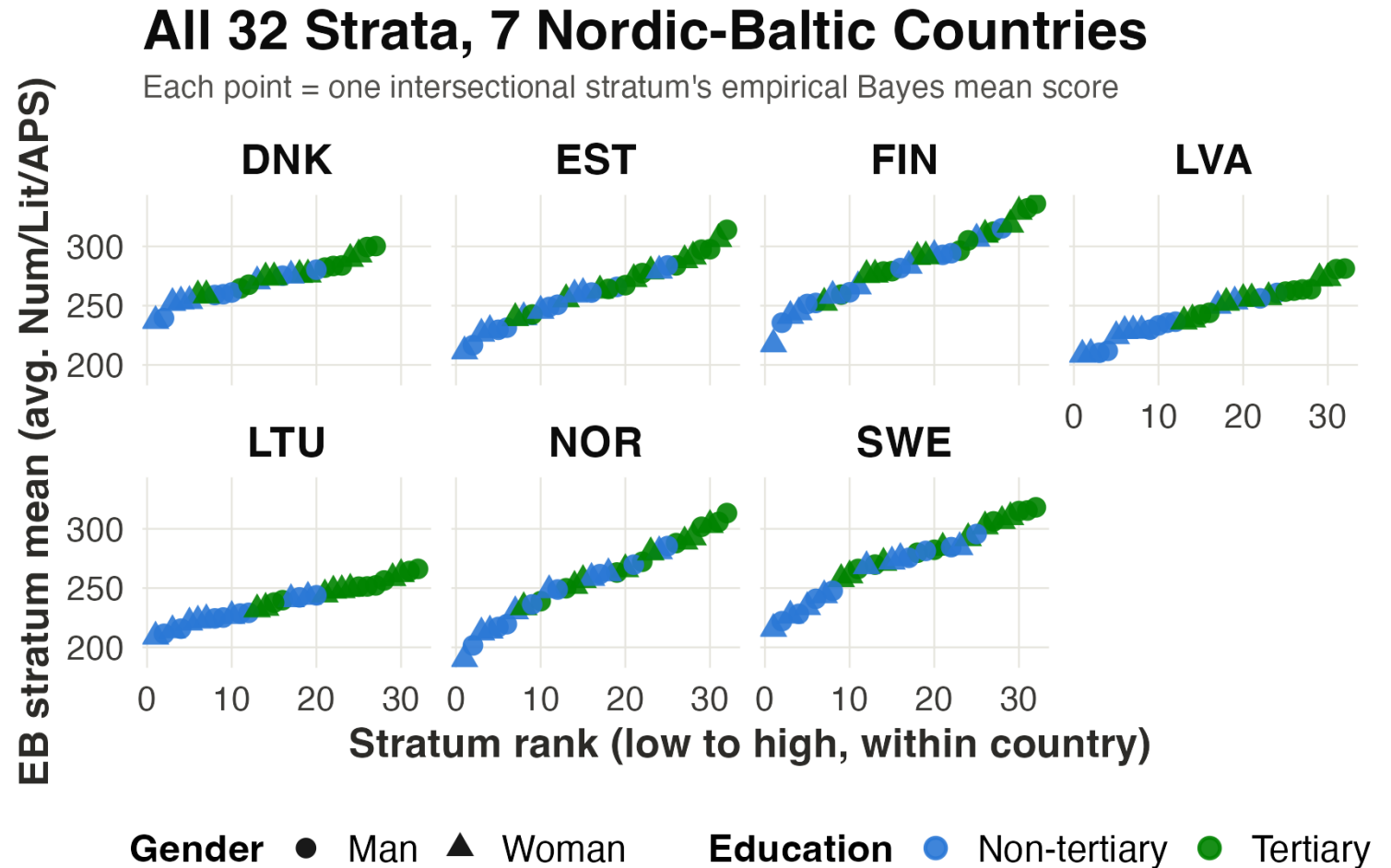
Two-level model with correlated outcomes and no predictors

Model 2 (Additive Model)

Two-level model with correlated outcomes and main effects of the stratum variables

Empirical Bayes stratum profile—Nordic-Baltic countries

All 32 EB stratum means, 7 Nordic-Baltic countries, by education (color) and gender (shape).

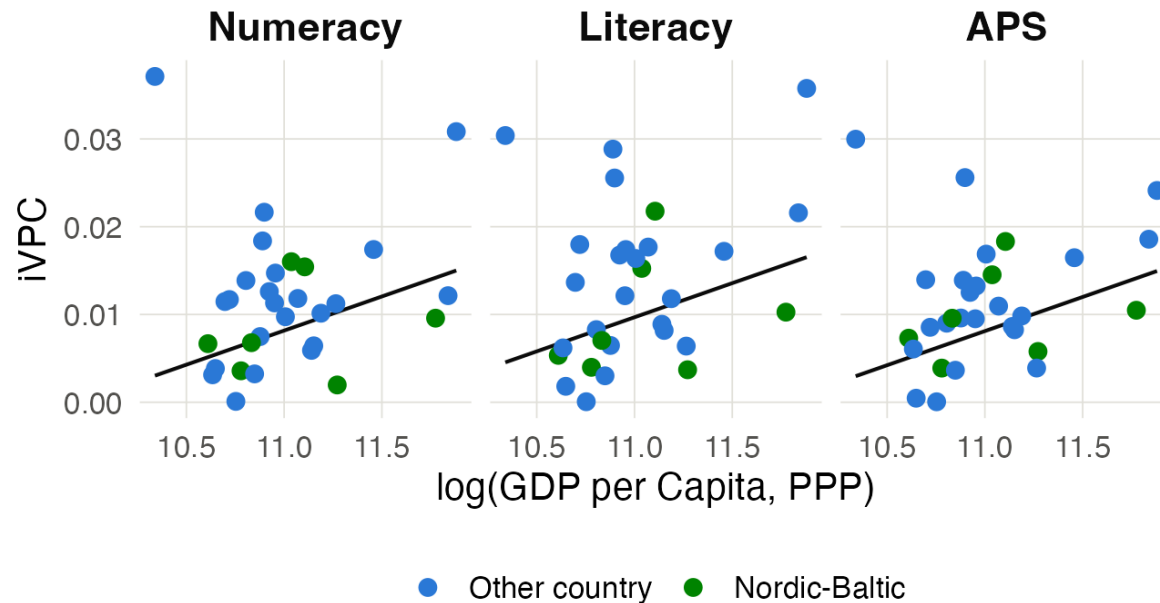


Explaining Heterogeneity in Intersectionality

Moderators of heterogeneity in iVPC

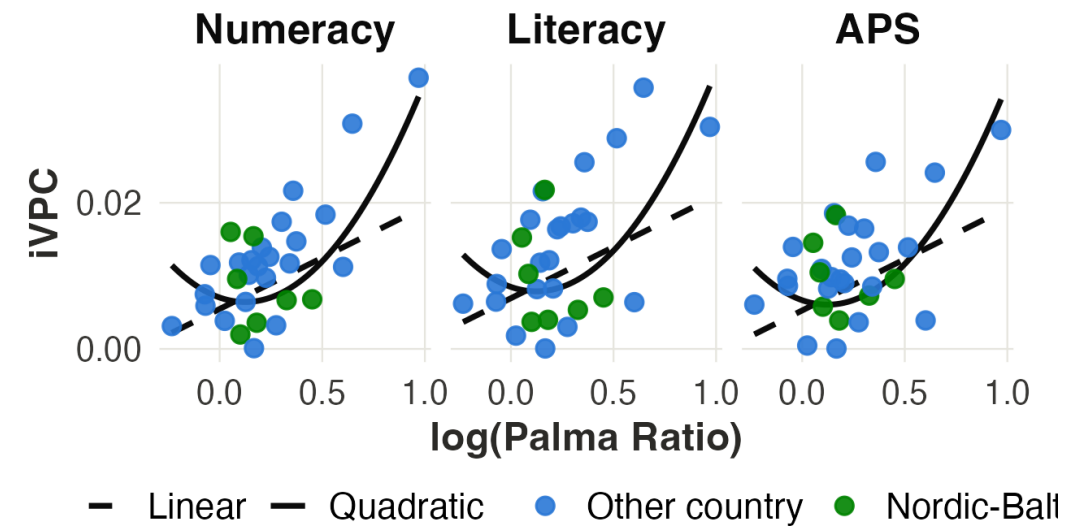
iVPC vs. GDP per Capita

Linear term $p = 0.035$ — significant (quadratic term n.s., $p = .307$)



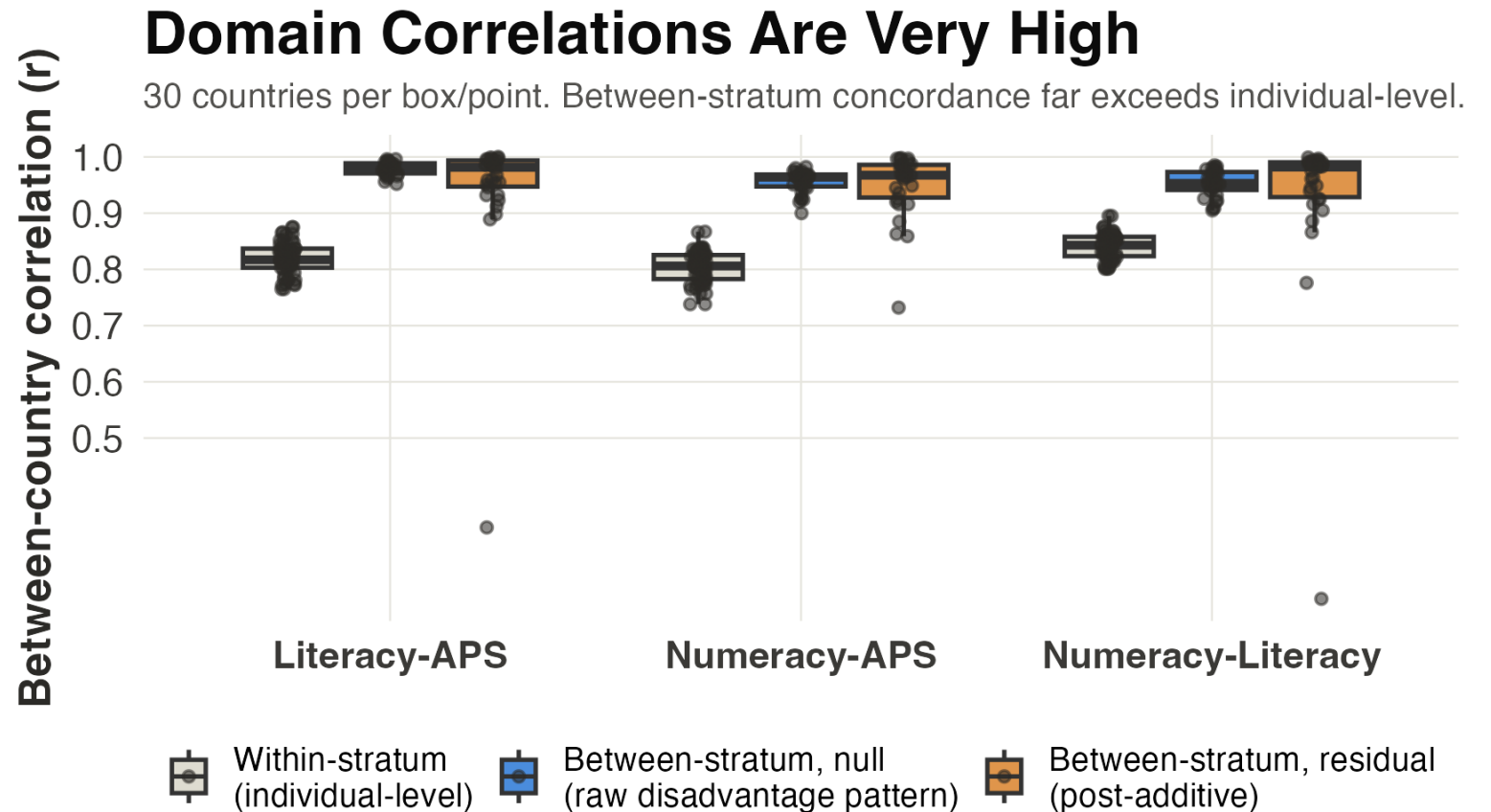
iVPC vs. Palma Ratio

Quadratic term LRT $p = 0.009$ — curvature is significant



Domain-general disadvantage

- Between-stratum correlations across NUM/LIT/APS: $r = .95-.98$ — a stratum disadvantaged in one domain is disadvantaged in almost all of them.
- Individual-level correlations are lower ($r = .80-.84$) — group-level concordance is not just individual-level noise averaging out.
- Residual (post-additive) correlations stay high on average (.93–.95) but are far more cross-country variable.



Complete-case sensitivity comparison

Metric	Imputed vs. complete-case agreement
VPC (<i>null model</i>), NUM/LIT/APS	Mean abs. diff = 0.011–0.013, Correlations = 0.98–0.99
VPC (<i>additive model</i>), NUM/LIT/APS	Mean abs. diff $\approx$ 0.0035, Correlation = 0.89–0.93
PCV , NUM/LIT/APS	Mean abs. diff = 0.008–0.012, Correlations = 0.94–0.97

Imputed-data vs. complete-case (listwise deletion) estimates. All correlations ≥ 0.89 ; the additive-model/PCV-adjacent metrics are slightly lower (0.89–0.93) but still show strong agreement.

Statistical power and MDES

- **Post-hoc power** (evaluated at the observed pooled estimate) is near-ceiling for all three effect sizes—**VPC $\approx$ 100%**, **1-PCV $\approx$ 99.98%**, **iVPC $\approx$ 99.97%** (average across domains)
- **MDES** (minimum detectable true effect at 80% power, this design's own τ/ρ): **VPC = 0.051**, **1-PCV = 0.014**, **iVPC = 0.0044**—all comfortably below the observed pooled estimates (0.22–0.25, 0.030–0.033, 0.008–0.010)

Both computed via the R package POMADE (Vembye & Pustejovsky, 2026), model CHE-RVE, $J = 30$ countries $\times$ 3 correlated domain effect sizes.

Why partial pooling matters

Some strata are very sparse or even empty. Raw subgroup means would be unstable for these cells.

Stratum Cell Sizes: Denmark & Finland

All 32 strata, sorted by size. Small cells labeled; adequate ($n \geq 20$) cells left blank.

