Similarities and differences between groups of countries concerning relative weaknesses and strengths

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The role of achievement test items

- A test consists of numerous test items that together represent a good measurement of the actual competency.
- This collection of items must ensure high validity as well as reliability:
  - Validity: good coverage of the decided framework concerning types of competencies, item formats, difficulties, etc
  - Reliability: ensuring low measurement errors, giving good estimates of their magnitude
- A high quality test score can then be calculated by combining data from many items into a score
  - How to do that depend on the detailed measurement model

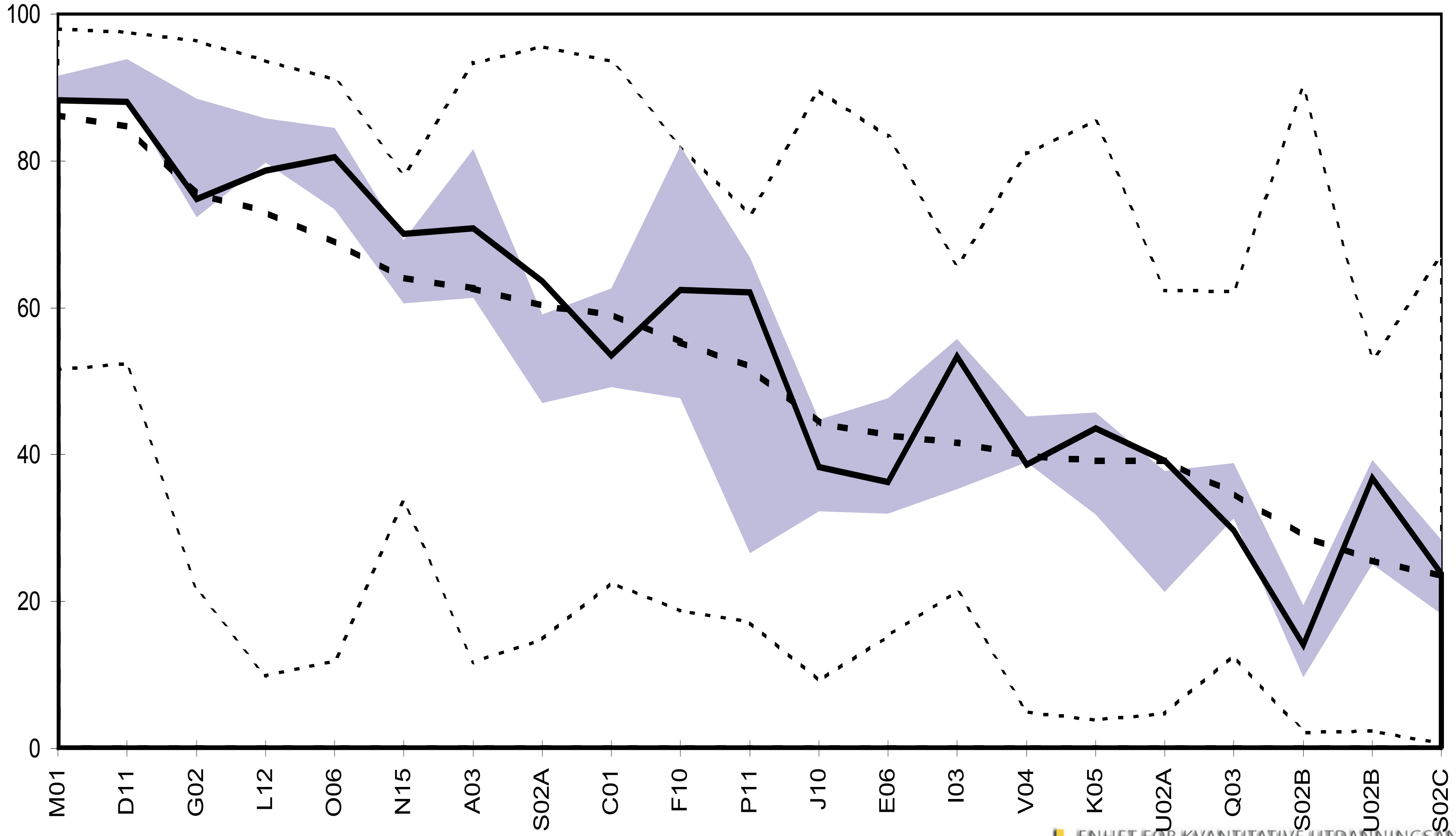
A test item perspective

- From response to item score:
  - for MC items: *which* alternative chosen
  - for constructed (open) response items: *what* was written, type of correct or wrong response
    - For many items reports include this information
    - Two-digit scoring rubrics
- From item scores to scale score
  - Only ”sum” of p-values ”counts”
  - Valuable to investigate also the ”90 % lost” information
  - Not only random noise!!!

Looking for interesting secondary information from test items

- Two examples:
  - Investigating student conceptual understanding by investigating responses to one or a few items
    - A number of such studies has been carried out at EKVA
  - Looking for meaningful patterns in the item residuals (remains when the score aspect has been taken out)
    - An in-depth study of relative strengths and weaknesses for countries

Norway in the ”Nordic river” (excl. Finland) p-values items in TIMSS 1995



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Calculating p-value residuals

- How much better or worse is a national p-value than expected, considering
  - the international difficulty of the item
  - and the overall score for the country?

Looking for patterns in the residual p-value matrix

- Possible patterns of countries
  - pairs or groups of countries showing similar strengths and weaknesses
- or of items
  - groups of items that tend to discriminate similarly between countries
- Tools: correlations, cluster analysis etc.

In practice

- Very simple procedure
  - Start with a p-value matrix: item by country
  - Average p-values calculated both for countries and for items
  - Subtract actual item average as well as country average to get country/item residuals
  - How much better or worse did a particular country score than expected from the country's overall score and the item's overall difficulty?

Countries	A	B	C	Mean
Item 1	45	60	32	45,7
Item 2	57	80	53	63,3
Item 3	38	65	38	47,0
Mean	46,7	68,3	41,0	**52,0**

Countries	A	B	C	Mean
Item 1	-1,7	-8,3	-9,0	-6,3
Item 2	10,3	11,7	12,0	11,3
Item 3	-8,7	-3,3	-3,0	-5,0
Mean	0,0	0,0	0,0	**0,0**

Countries	A	B	C	Mean
Item 1	4,7	-2,0	-2,7	0,0
Item 2	-1,0	0,3	0,7	0,0
Item 3	-3,7	1,7	2,0	0,0
Mean	0,0	0,0	0,0	0,0

Correlations of p-value residuals between Norway and all other countries. Mathematics. TIMSS 1995

TOP 10		BOTTOM 10	
		….	
Sweden	.68	Kuwait	-.25
Iceland	.55	Israel	-.25
Denmark	.47	Singapore	-.30
Germany	.40	Thailand	-.34
Switzerland	.37	Korea	-.34
Scotland	.36	Russia	-.35
New Zealand	.36	Hong Kong	-.37
England	.35	Bulgaria	-.38
Netherlands	.30	Iran	-.43
Australia	.29	Romania	-.44

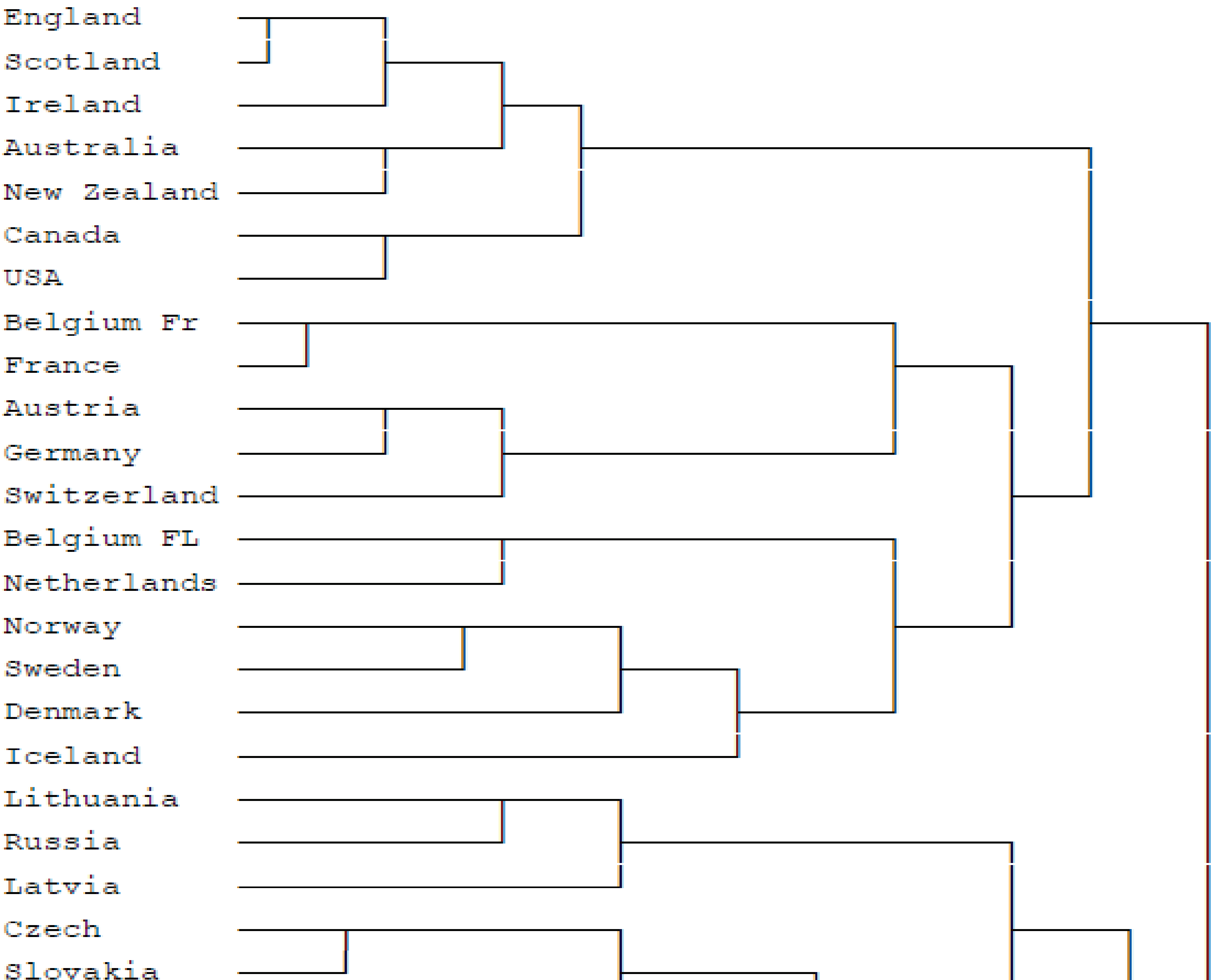
Clusters with labels and reliability TIMSS Science 1995

- East Asia (.52): Hong Kong, Japan, Korea, Singapore, Thailand
- East Europe (.68): Bulgaria, Czech rep, Hungary, Latvia, Lithuaenia, Romania, Russia, Slovac rep, Slovenia
- English-speaking (.88): Australia, Canada, England, Ireland, New Zealand, Scotland, USA
- North Europe (.73): Denmark, Iceland, Norway, Sweden, Belgium (Fl), Netherlands, Switzerland
- South Europe (44): Cyprus, Greece, Portugal, Spain

Cluster analysis:

- A method to cluster variables by agglomeration of cases into ever larger groups based on similarities
- Various measures of similarity, e.g.
  - Correlations (most common), «Distance» etc
- Various rules for combining groups, e.g.
  - Internal cohesion, External isolation

TIMSS Science 2003 (split into halves)



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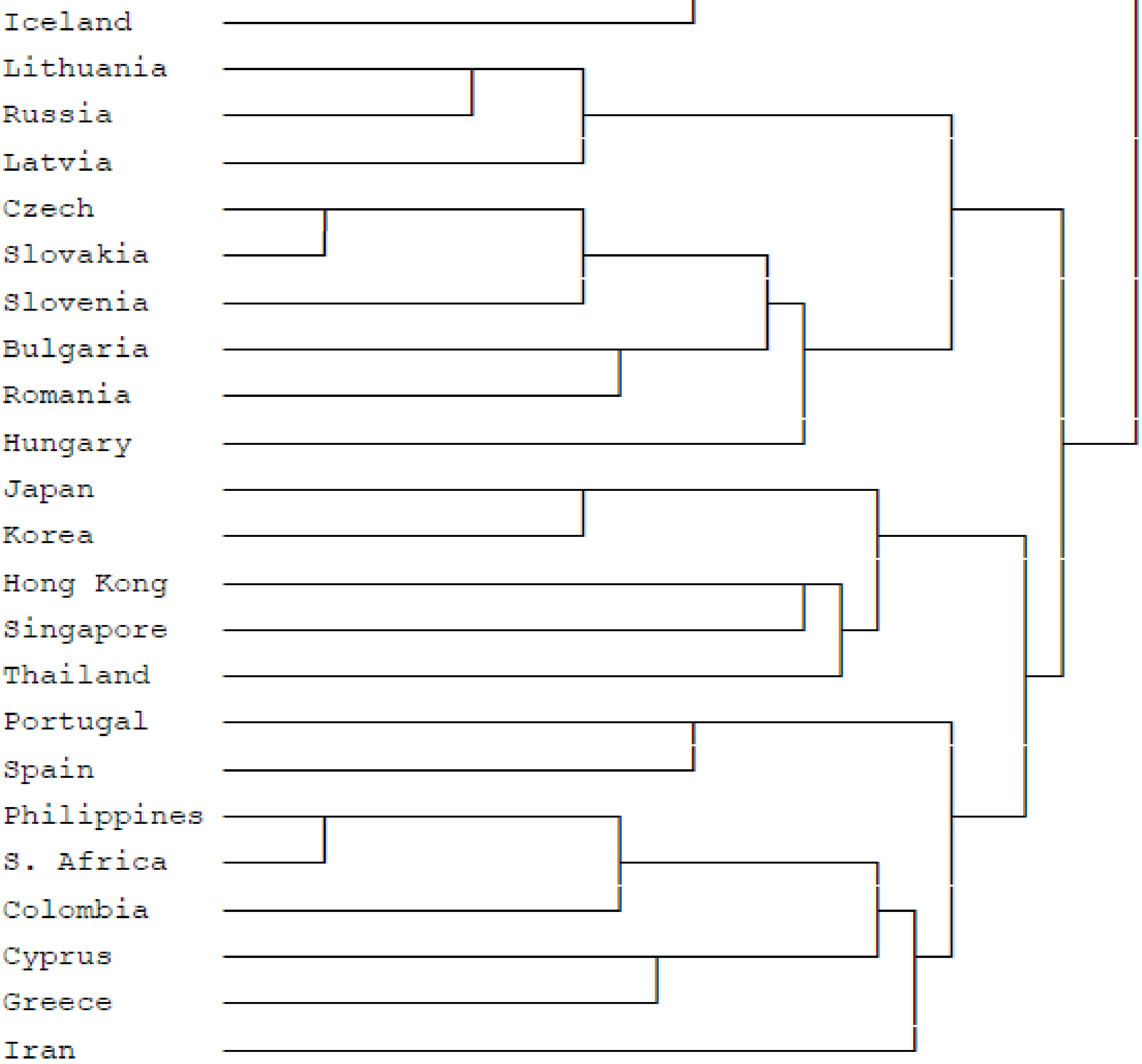
Iceland
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Bulgaria
Romania
Hungary
Japan
Korea
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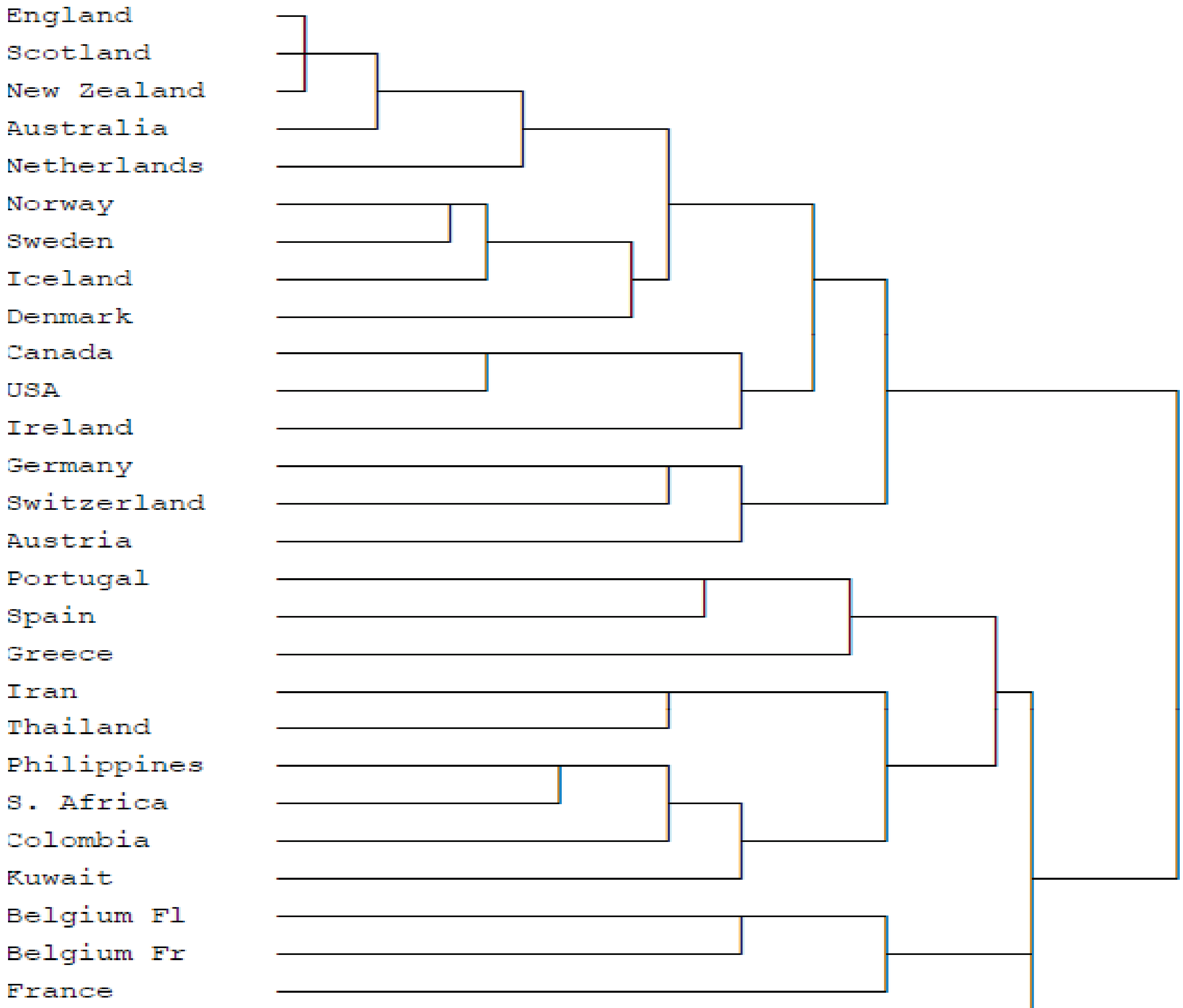
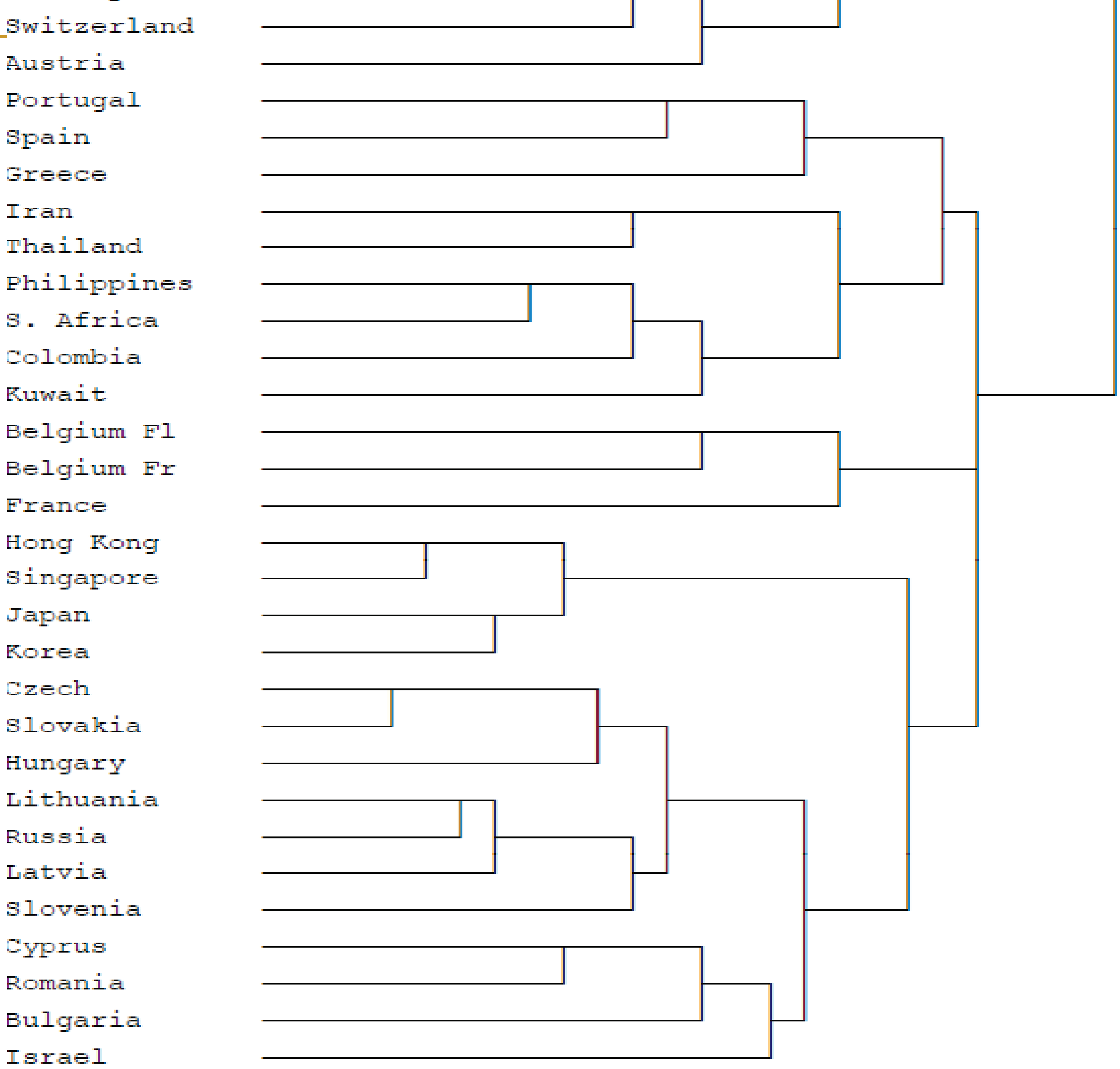
Thailand
Portugal
Spain
Philippines
S. Africa
Colombia
Cyprus
Greece
Iran

TIMSS 2003 Math (in halves)




Switzerland
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Philippines
S. Africa
Colombia
Kuwait
Belgium Fl
Belgium Fr
France
Hong Kong
Singapore
Japan
Korea
Czech
Slovakia
Hungary
Lithuania
Russia
Latvia
Slovenia
Cyprus
Romania
Bulgaria
Israel

PISA science 2006

- Including test items as well as student attitudes towards science

Groups and countries 2006

East Central Europe (former communist)

English-speaking

French/Dutch

German-speaking

Islamic

Latin America

Latin Europe

Nordic

North-East Asia

Why, and So what?

- Actual clustering «mechanisms»: language, geography, political and cultural history, religion, curricular influences etc
- Such groupings of countries invites to focus on:
  - Identifying what constitutes the particularity for each group, and looking for influences whithin and between groups
  - Encouriging regional (groupwise) study reports to better interpretation of national test results concerning important challenges

EKVA

Faculty of Education, University of Oslo

- Norwegian center for administering and running tests and other quantitative studies
  - Internationally: IEA studies, PISA etc
  - National assessments
  - Master- and PhD quantitative projects in science/math/reading education
- International studies:
  - Main task: administrating, running, recording according to given procedures
  - National reporting focusing on Norwegian results/standing in an international context
  - Focusing on comparison with nabour countries
  - Also focusing on trends and links between studies

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Some references

Kjærnsli & Lie:

- *International Journal of Science Education,, 2011/33, p 121-144*
- *Scandinavian Journal of Educational Research, 48/3, p 271-286*
- *IEA Research Conference, Cyprus 2005*