Numeracy Achievement Gaps of Low- and High-Performing Adults: An Analysis Within and Across Countries

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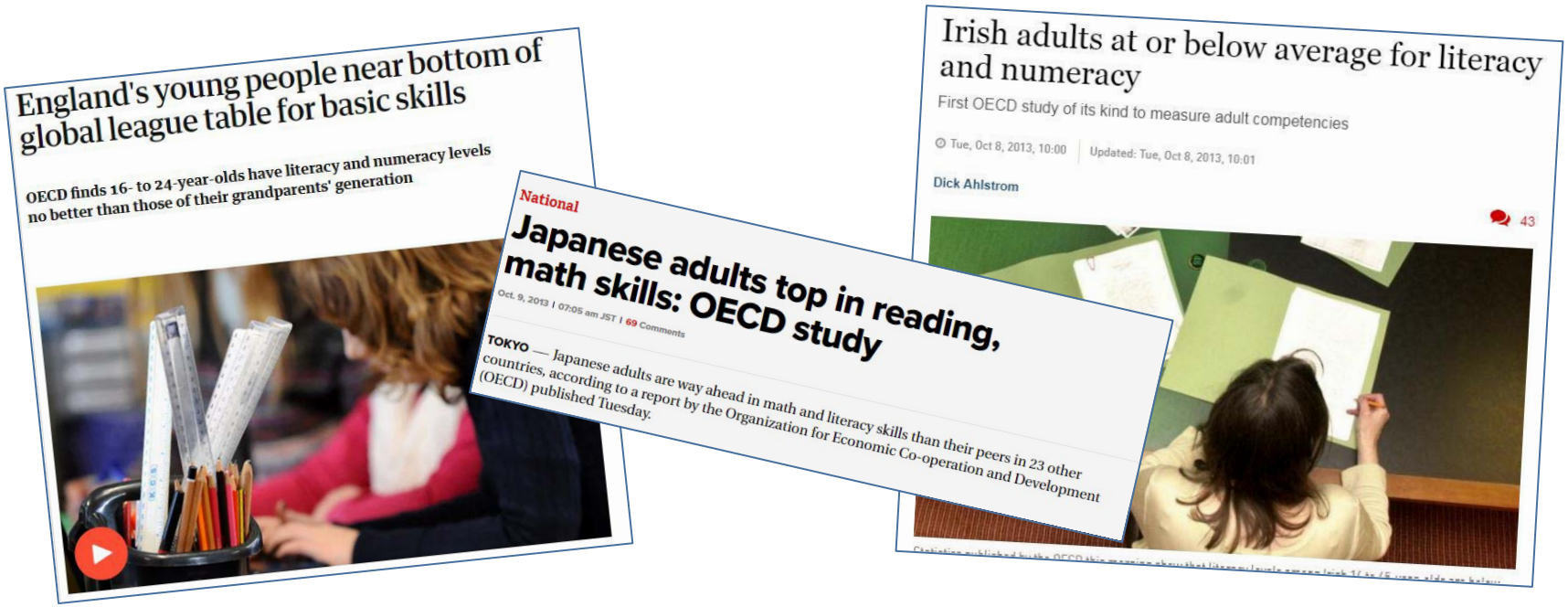
Perspectives/Theoretical Framework

- News headlines focus on country rankings based on average country performance (Ahlstrom, 2013; Kameda, 2013; Ramesh, 2013)



Perspectives/Theoretical Framework

- Averages do not provide information about performance across the achievement distribution, particularly among low- and high-performing adults
- Insufficient information about a country's success in educating its low- and high-performing students, who need an appropriate and challenging education if they are to become contributing members of society (Badescu, D'Hombres, and Villalba, 2011; Barone and van de Werfhorst, 2011)
- Lack of research systematically examining and statistically testing country-level gaps in numeracy achievement between low- and high-performing adults

Perspectives/Theoretical Framework

- Research suggests that numeracy skills play an important role in employment outcomes; better numeracy has been associated with higher earnings and higher employment rates (McIntosh & Vignoles, 2001)
- Intergenerational earnings mobility is higher in countries with higher income equality; lower in countries with lower income equality (OECD, 2011)
- Prior research has not specifically examined the relationship between country-level income inequality and gaps in the numeracy achievement of low- and high-performing adults

Research Questions

1. What is the extent of the variation seen across countries in the numeracy achievement of low- and high-performing adults, especially relative to average performance within countries?
2. What is the extent of the variation seen across countries in the size of adults' within-country achievement gaps in numeracy and how is the size of these achievement gaps related to countries' average performance?
3. Using country-level data, what is the relationship between income inequality and numeracy achievement gaps?

Methods

- 2012/2014 Program for the International Assessment of Adult Competencies (PIAAC)
- Adult (16- to 65-year-olds) numeracy data
- Participating education systems:
  - 25 OECD countries
    - Austria, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Republic of Korea, Slovak Republic, Slovenia, Spain, Sweden, Turkey, United States
  - 3 OECD sub-national entities
    - Flanders (Belgium), England (UK), Northern Ireland (UK)
  - 3 non-OECD countries
    - Cyprus, Lithuania, Singapore

NOTE: For the purpose of our analyses, England and Northern Ireland are presented as one (United Kingdom).

Methods—Continued

- Examine countries' average scores and their cut-point scores at the 10th, 25th, 75th, and 90th percentiles
  - 10th and 25th percentiles representing low side of achievement distribution
  - 75th and 90th percentiles representing high side of achievement distribution
  - Achievement gap between low- and high-performing adults in each country represented by difference between 10th percentile and 90th percentile cut-point scores

Methods—Continued

- Income inequality measured using Gini coefficient
  - Value of 0 represents perfect income equality, while a value of 1 represents absolute income inequality
  - World Bank as primary data source

Primary Statistical Tool

- Analysis of research questions was conducted using the PIAAC International Data Explorer (IDE)

International Data Explorer: https://nces.ed.gov/surveys/international/ide/
NCES PIAAC website: https://nces.ed.gov/surveys/piaac/

Results

Research Question #1

What is the extent of the variation seen across countries in the numeracy achievement of low- and high-performing adults, especially relative to average performance within countries?

Table 1. Adults' average numeracy scores, cut-point scores at the 10th, 25th, 75th, and 90th percentiles, and gap between 90th and 10th percentiles, by country: 2012/2014

Jurisdiction	Average	10th Percentile	25th Percentile	75th Percentile	90th Percentile	Gap (between 90th and 10th percentiles)
Japan	288	232	261	318	342	110
Finland	282	217	251	317	345	128
Flanders (Belgium)	280	214	249	316	342	128
Netherlands	280	215	251	315	340	125
Sweden	279	210	249	316	343	133
Norway	278	210	248	315	341	132
Denmark	278	213	247	313	339	126
Slovak Republic	276	214	249	308	331	117
Czech Republic	276	218	248	305	329	111
Austria	275	213	246	309	334	121
Estonia	273	215	245	304	329	114
Germany	272	202	238	309	335	133
New Zealand	271	201	237	309	338	137
Lithuania	267	207	238	300	326	120
Canada	265	194	231	304	332	138
Cyprus	265	205	236	296	321	116
Republic of Korea	263	204	236	295	318	115
Average of All Jurisdictions	**263**	**195**	**231**	**299**	**326**	**131**
England and Northern Ireland (UK)	262	192	227	300	329	138
Poland	260	194	229	294	322	128
Slovenia	258	187	224	295	322	135
Singapore	257	159	218	306	334	175
United States	257	184	221	297	326	143
Ireland	256	190	225	291	319	129
France	254	180	220	294	322	142
Greece	252	190	220	284	312	122
Israel	251	169	213	296	327	158
Italy	247	183	215	282	309	126
Spain	246	178	216	281	307	130
Turkey	219	145	185	258	287	142
Chile	206	128	166	248	282	154

Figure 1: Cut-point scores of adults in numeracy at the 10th and 90th percentiles, by country: 2012/2014

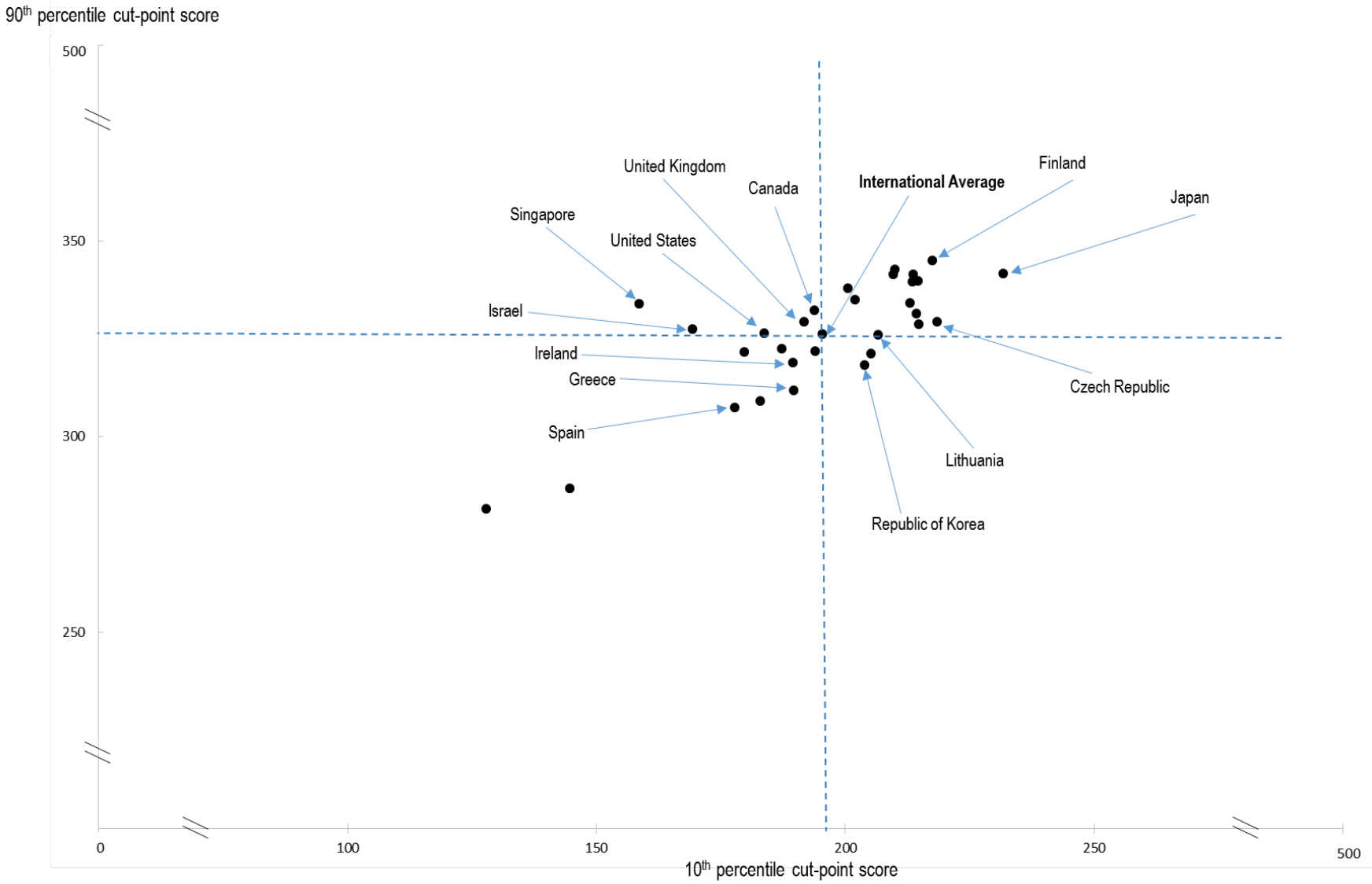


Table 2a: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in the United Kingdom and Ireland: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
United Kingdom	192	227	▲ 262	▲ 300	▲ 329
Ireland	190	225	256	291	319

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

NOTE: United Kingdom includes England and Northern Ireland

Table 2b: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in the Czech Republic and United Kingdom: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Czech Republic	▲ 218	▲ 248	▲ **276**	▲ 305	329
United Kingdom	192	227	**262**	300	329

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

Table 2c: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in Lithuania and the United States: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Lithuania	▲ 207	▲ 238	▲ **267**	300	326
United States	184	221	**257**	297	326

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

Table 2d. Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentile in Japan and Finland: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Japan	▲ 232	▲ 261	▲ **288**	318	342
Finland	217	251	**282**	317	345

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

Table 2e: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in Singapore and Spain: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Singapore	159	218	▲ 257	▲ 306	▲ 334
Spain	▲ 178	216	246	281	307

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

Table 2f: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in Greece and Israel: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Greece	▲ 190	▲ 220	**252**	284	312
Israel	169	213	**251**	▲ 296	▲ 327

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

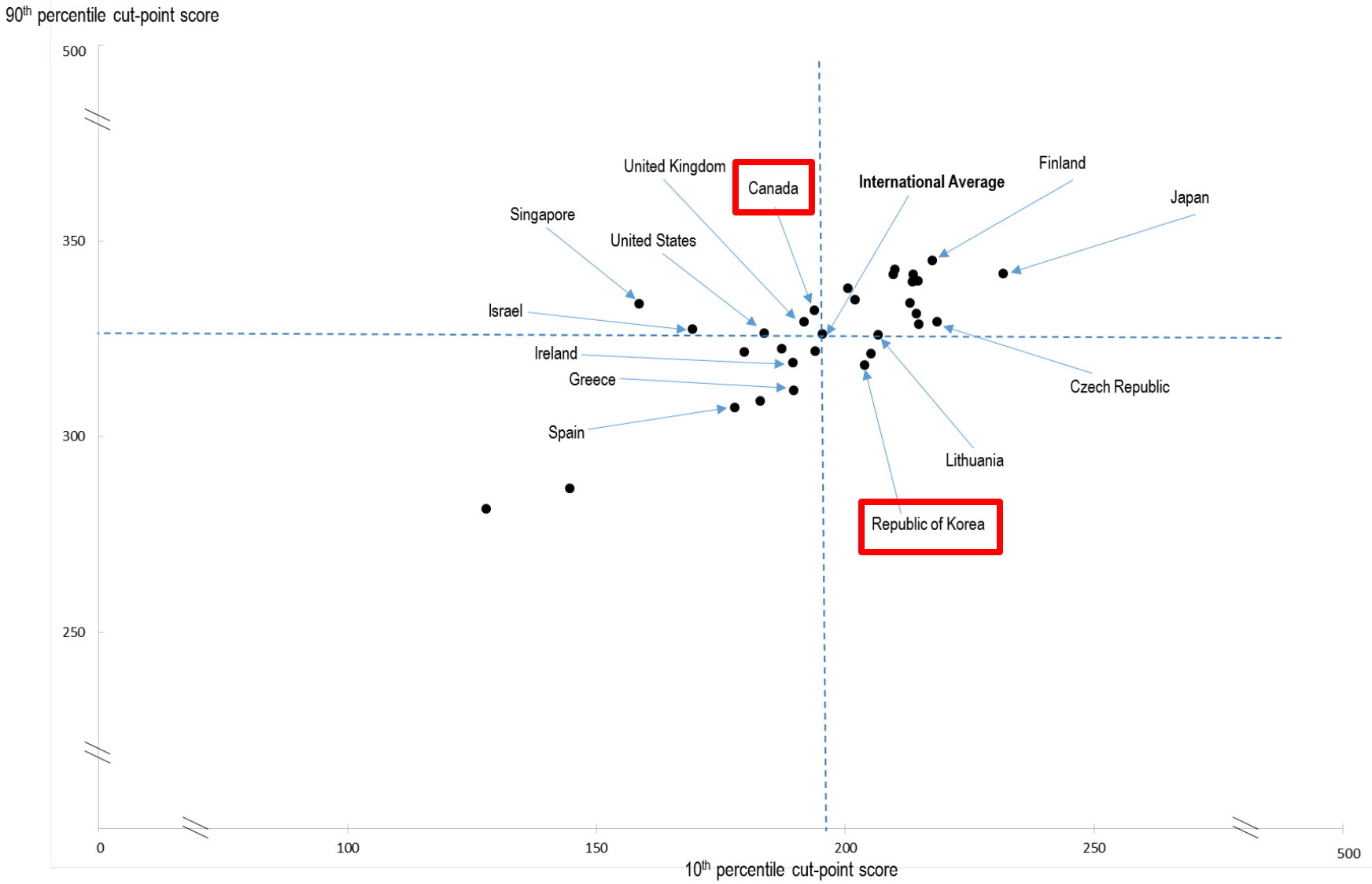
Table 2g: Differences in adults' average numeracy scores and cut-point scores at the 10th, 25th, 75th, and 90th percentiles in Canada and the Republic of Korea: 2012/2014

Education system	Cut-point score at 10th percentile	Cut-point score at 25th percentile	Average score	Cut-point score at 75th percentile	Cut-point score at 90th percentile
Canada	194	231	**265**	▲ 304	▲ 332
Republic of Korea	▲ 204	▲ 236	**263**	295	318

▲ Score is higher than the comparison score at $p < .05$.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Program for the International Assessment of Adult Competencies (PIAAC), 2012/14.

Figure 1: Cut-point scores of adults in numeracy at the 10th and 90th percentiles, by education system: 2012/2014



Research Question #2

What is the extent of the variation seen across countries in the size of students' within-country achievement gaps in numeracy and how is the size of these achievement gaps related to countries' average performance?

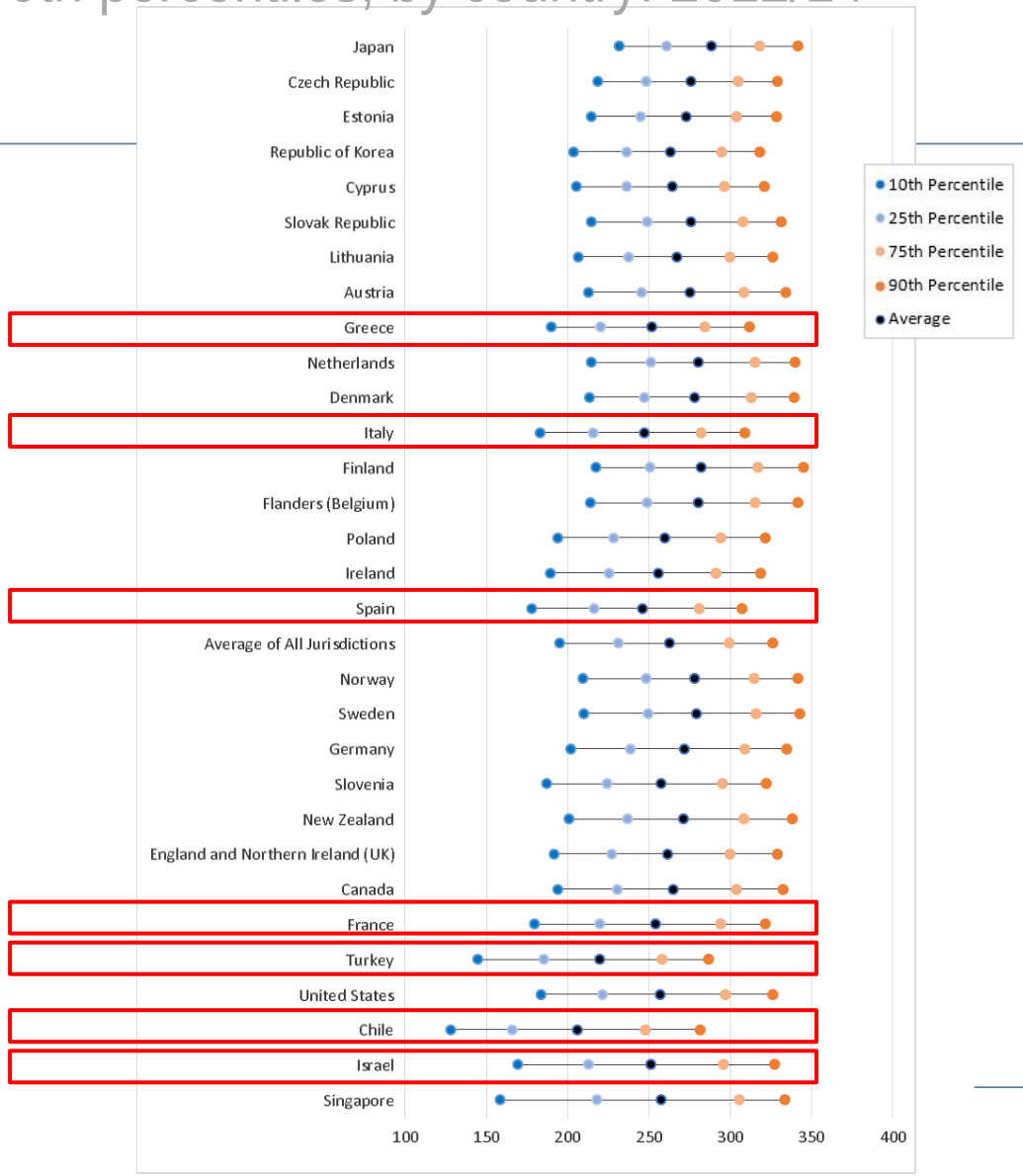
Figure 2: Average numeracy scores and achievement gaps of adults at the 10th, 25th, 75th, and 90th percentiles, by country: 2012/14

Highest performing countries

NOTE: Countries sorted by achievement gap (smallest to largest)

Figure 2: Average numeracy scores and achievement gaps of adults at the 10th, 25th, 75th, and 90th percentiles, by country: 2012/14

Lowest performing countries

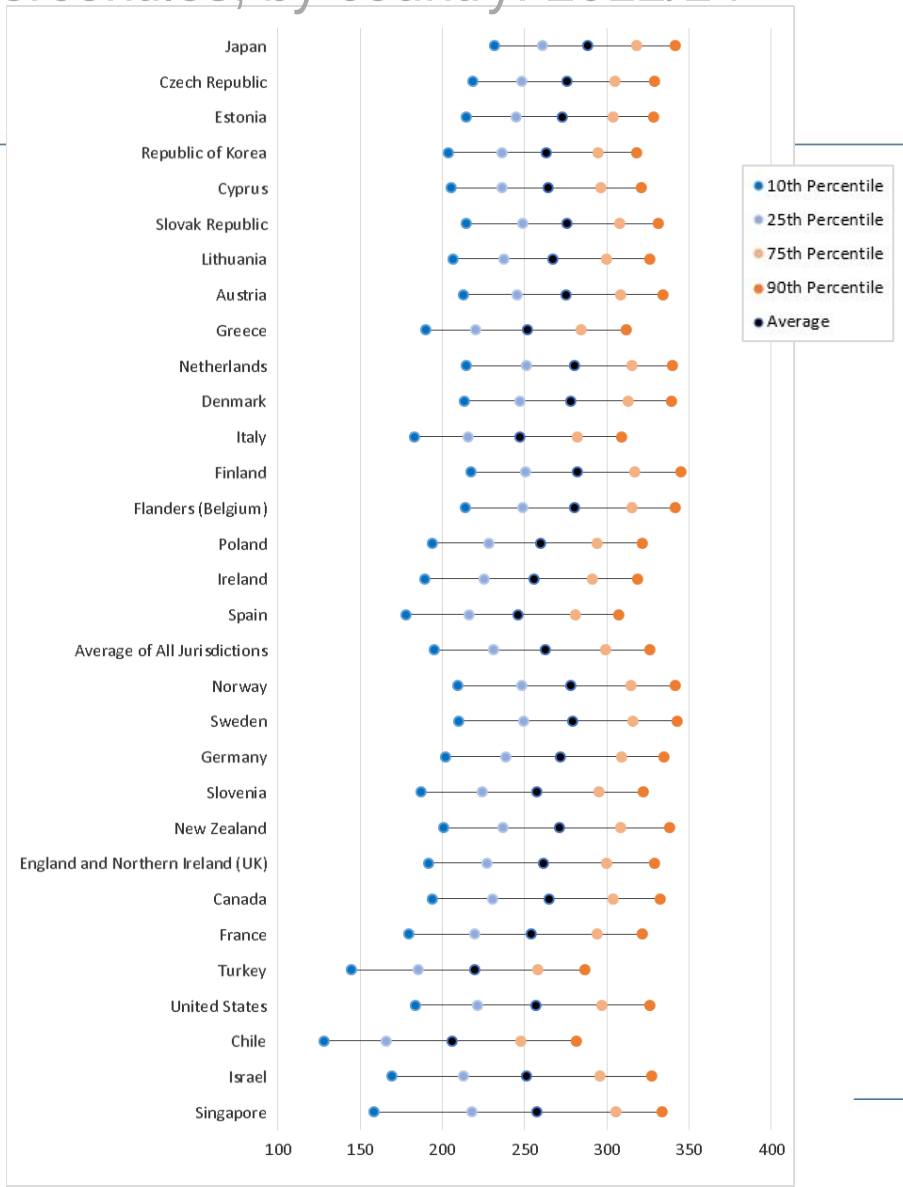


NOTE: Countries sorted by achievement gap (smallest to largest)

Figure 2: Average numeracy scores and achievement gaps of adults at the 10th, 25th, 75th, and 90th percentiles, by country: 2012/14

Correlation between average scores and size of achievement gaps:

$r = -.513$, $p < .01$



NOTE: Countries sorted by achievement gap (smallest to largest)

Research Question #3

Using country-level data, what is the relationship between income inequality and numeracy achievement gaps?

Gini coefficient

- Correlation between income inequality and numeracy achievement gaps

Countries (N) = 29

$r = .634, p < .01$

NOTE: Gini coefficient missing for New Zealand

Conclusions, Policy Implications, Study Limitations, and Future Research

Conclusions

- Examining countries' average achievement fails to provide information on the numeracy skills of countries' low- and high-performing adults
- Size of numeracy achievement gaps varies substantially across countries; some countries have a more equitable distribution of numeracy performance and some have larger performance gaps
- Smaller achievement gaps within countries is associated with higher average scores
- Smaller achievement gaps within countries is associated with a more equitable distribution of income

Policy Implications

- Countries that are committed to fostering equity and opportunity should be concerned about maximizing the potential of both their low- and high-performing adults in the workforce
- Efforts among industrialized countries to reduce the disparity between low- and high-performing adults in numeracy may also help to reduce income inequality, and vice versa

Study Limitations

- Data are correlational
- Data are only available for one time point; unable to conduct analyses over time
- Countries included in study are primarily OECD countries

Future Research

- Once PIAAC trend data becomes available, interested in examining change in numeracy achievement gaps (both within and across countries)

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Thank you!

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